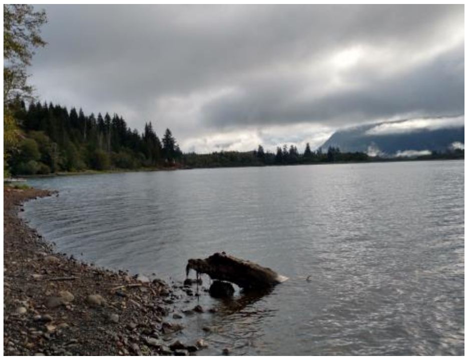
Quinault Indian Nation Shoreline Inventory and Characterization Report

Quinault Indian Nation
Taholah, Washington



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Quinault Indian Nation Shoreline Inventory and Characterization Report

Project Information

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Reviewing Agency

ANA Administration for Native Americans

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1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE

This Shoreline Inventory and Characterization report has been prepared in support of an update to the Quinault Indian Nation's (QIN's) Shoreline Management Plan (SMP) (Figure 1). The SMP guides the use and protection of shorelines within the Quinault Indian Reservation (Reservation), with a goal of managing the QIN's shoreline areas to allow for shoreline-dependent uses, Tribal access, management of existing developments, and ongoing commercial forestry and fishery uses while providing for the long-term protection and restoration of the shoreline's natural environment. This report describes existing conditions and characterizes ecological functions of shoreline areas, which include lands along major rivers, the coast, and Lake Quinault. This report serves as a baseline for shoreline management planning purposes, and provides metrics against which the impacts of future land uses and development in shoreline areas can be measured.

The QIN is a sovereign nation, and thus is not required to follow state guidelines when creating their Shoreline Management Plan (SMP). The QIN SMP will reflect the Nation's unique shoreline uses, governance, and interests. This report, which is developed to provide a technical basis for the SMP, has two main components: A Shoreline Inventory and a local Shoreline Characterization. Based on the summary of shoreline inventory and characterization data, this report provides a summary of current and anticipated shoreline uses, and management recommendations based on those uses and the local characteristics of affected shorelines."

1.1.1 Shoreline Inventory

The shoreline inventory is intended to compile available information from various sources to provide a description of the existing conditions within individual portions, or reaches, of the coastal, river, and lake Shoreline Analysis Areas (SAAs). The SAAs for Coastal, Riverine and Lacustrine systems are defined and described in Section 1.2. The goals of the inventory are as follows:

- Identify and map the SAAs, to which the SMP will apply
- Summarize the regional environmental context
- Identify watershed processes and areas influencing QIN shorelines
- Determine coastal, riverine, and lake study segment boundaries (reaches)
- Map shoreline physical, biological, and cultural features
- Summarize ecological functions and uses by reach
- Summarize shoreline characterization
- Summarize and map protection/restoration opportunities
- Identify existing and future shoreline uses and areas for improved recreational access
- Identify management issues of concern

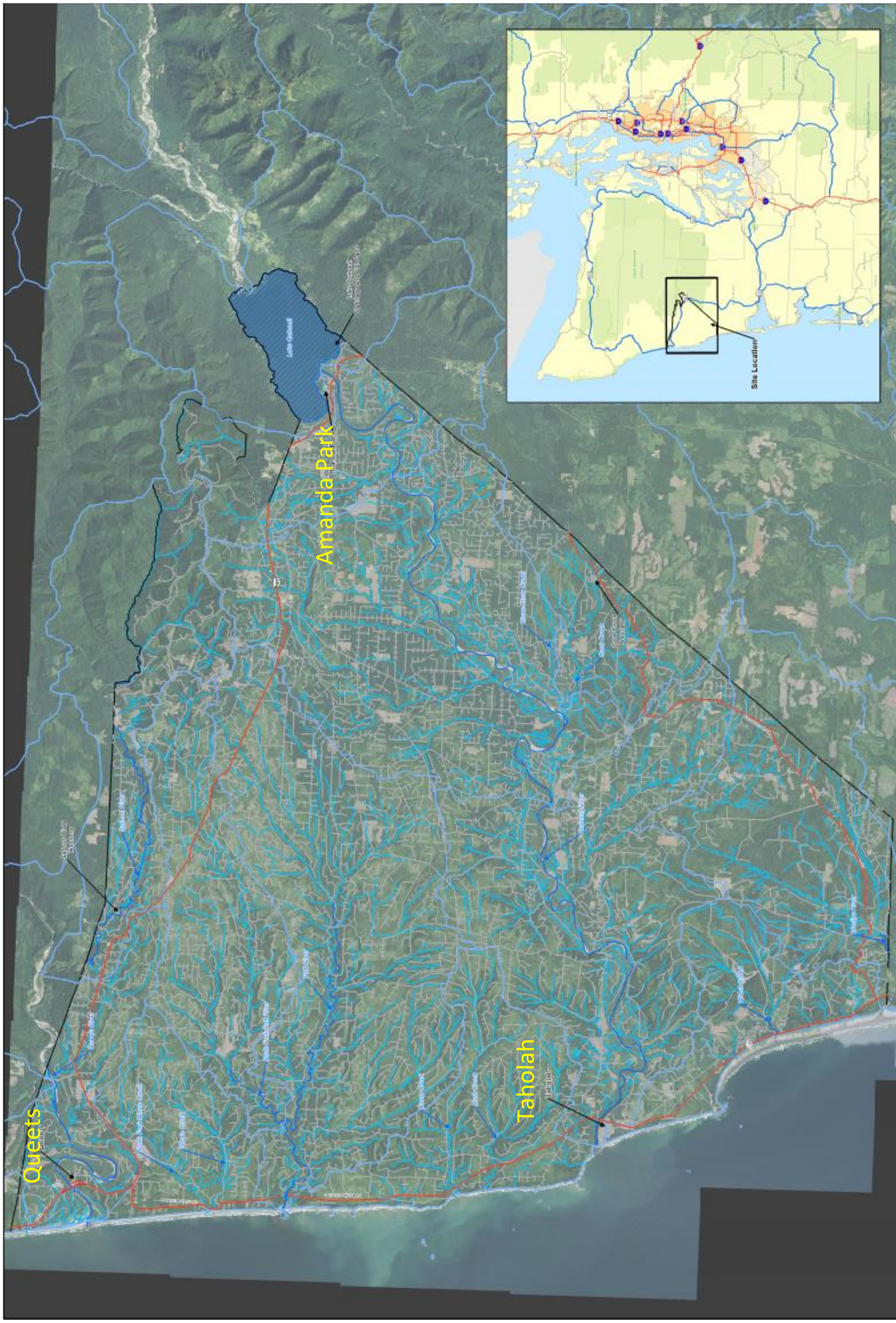

Figure 1. Project Area Location Map (adapted from Digital Map A-1, Vicinity Map).

1.1.2 Local Shoreline Characterization

The purpose of the shoreline characterization is to document the regional and local physical process and ecological conditions of the SAA reaches, with the intent of achieving a meaningful understanding of current shoreline ecological functions and appropriate uses for each reach.

The characterization identifies the relative quality and functionality of shoreline areas. As such, it is intended to highlight areas with unique or sensitive attributes, which deserve special consideration regarding conservation or limitations on land uses that have the potential to degrade sensitive ecological conditions. The characterization also documents reasonably foreseeable future uses and developments in the SAA, and identifies opportunities for restoration of shoreline resources and ecological functions, which can act to balance ongoing and future disturbances so that the net ecological shoreline functions remain in a stable or improved condition.

1.2 Shoreline Analysis Areas (SAAs) Overview

The Reservation SAA includes all areas determined to have a strong connection with waters designated as being of special importance to the QIN. It includes shorelines associated with major rivers, the marine coastline, and Lake Quinault, within the Reservation. Major rivers are those that have been designated as Type D Rivers by the QIN Draft Forest Plan (QIN and Bureau of Indian Affairs 2017).

The following water bodies are the basis of the SAAs covered in this report (Table 1):

- Pacific Ocean – the entire marine coastal shoreline within Reservation
- Queets River – from the Pacific coast to the northern Reservation boundary
- Salmon River – from to the northern Reservation boundary upstream to the confluence point with the south fork of the Salmon River
- North Fork Raft River – from the main stem of the Raft River to the upstream confluence point with Wolf Creek
- Raft River – from the Pacific coast upstream to the confluence point with Meadow and Lunch Creeks
- Quinault River – from the Pacific coast upstream to Lake Quinault
- Wreck Creek – from the Pacific coast upstream to the confluence point with the north fork of Wreck Creek
- Moclips River – from the southern Reservation boundary to the confluence point with the north fork of the Moclips River
- Lake Quinault – the entire lake shoreline

In addition to these water bodies, the SAAs include adjacent Shorelands, which are lands that have a strong ecological connection with the waters. For example, the SAAs associated with river systems include low-lying areas adjacent to rivers where the potential for flooding is high, as well as adjacent steep river valley sidewalls, which affect the rivers through erosion, woody debris, shade, habitat, nutrients, and various other factors described in Chapters 3 and 4. A more detailed description of how each of the SAA boundaries were determined is provided in Chapter 2.3.

Table 1. Shoreline Management Plan Analysis Areas[1]

Water Body	Shoreline Length* (miles)	Shorelands Area within the SAA (acres)
Pacific Ocean[2]	27.8	2,752
Queets River	8.7	2,815
Salmon River	12.0	1,456
North Fork Raft River	3.1	363
Raft River	12.9	1,660
Quinault River	34.5	12,957
Wreck Creek	0.7	108
Moclips River	1.0	94
Lake Quinault	2.6	84
Total[1]	103.3	22,289

* Note that totals include some overlap between river/coastal and river/lake shoreline areas.

1.3 Opportunities for Restoration

This report provides a description of habitat conditions in individual Reaches associated with shorelines in the Reservation. The habitat characterization information provides a baseline for identifying key areas of impairments, which can be used to identify, rank and find funding for critical habitat protection and restoration opportunities.

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[1] The nine Shoreline Analysis Areas (SAAs) are displayed on GIS maps, which are provided digitally.

[2] All Coastal Bluffs and Beaches from Mean High High Water (MHHW) elevation to Low Tide along the Pacific Ocean shoreline, extending from the northern Reservation boundary to the southern boundary.

2. METHODOLOGY

The SCJ Alliance/AECOM team (SCJA/AECOM) and the QIN worked collaboratively to acquire relevant baseline data, review the data, and establish an inventory of available shoreline reference material. Baseline data included geospatial/geographical information systems (GIS) data, reports, aerial photography, and input from staff, Tribal members, and local experts.

In conjunction with the review of reports and data, SCJA/AECOM conducted a limited field tour/inventory of selected representative coastal and riverine shoreline areas on September 7 and 8, 2016. During the tour, field conditions were documented through field notes and photos, and in some cases, located using a handheld global positioning systems (GPS) survey device. A detailed description of the shoreline inventory and characterization methodology is presented in the following sections.

2.1 Baseline Data Collection

The following information was documented, evaluated to determine its relevance and use, and summarized by reach, where applicable.

- Shoreline, adjacent land use patterns, transportation and utility facilities:
    - Extent of existing structures
    - Impervious surfaces
    - Vegetation and shoreline modifications
    - Water-oriented uses
    - Water crossings (bridges and culverts)
- Critical environments:
    - Wetlands
    - Aquifer recharge areas
    - Fish and wildlife habitat conservation areas
    - Geologically hazardous areas
- Frequently flooded areas
- Tsunami inundation areas (2010 and 2015 Models from Washington State Department of Natural Resources [WaDNR])
- Degraded areas and sites with ecological restoration potential
- Areas of special interest:
    - Priority habitats (wetlands, estuaries, beaches, etc.)
    - Prairies (as defined within the Reservation)
    - Developing or redeveloping waterfronts
    - Previously identified toxic or hazardous material clean-up sites
    - Landslides and eroding shorelines
- Conditions and regulations that affect shorelines:

- Surface water management
- Land use regulations

- Existing and potential shoreline public (QIN members) access sites:
  - Public and Tribal access sites
  - Public rights-of-way
  - Utility corridors
  - Conservation Areas
- Channel migration zones and floodplains
- Land use changes relative to cumulative impacts
- Archaeological and historic resources
- Data gaps
- Kamiak Ridge LLC Reach Assessment aerial photo and map record

Appendix II in Chapter 8 lists the specific GIS datasets gathered, analyzed, and summarized for this report as well as the source of the various GIS data layers.

GIS maps in large scale digital format are provided with this report. The digital maps are formatted to allow the user to zoom into areas of interest while maintaining high quality image detail. Some of the digital maps were adapted to create Figures in the report. The digital maps are referenced using the following figure numbering protocol.

Figure A-1: Vicinity Map
Figure A-2: Shoreline Analysis Areas
Figure A-3: Hydrography, Wetlands, and Floodplains
Figure A-4: Road System
Figure A-5: Geology, Geohazards, and Tsunami Inundation Areas
Figure A-6: Restoration Opportunities (Blocked Culverts)
Figure A-7: Ownership Types in Shoreline Analysis Areas
Figure A-8: Quinault Soil Survey Mapping in Shoreline Analysis Areas
Figure A-9: Zoning Classification in Shoreline Analysis Areas

2.2 Field Tour Documentation

After reviewing reports and base maps provided by the QIN Community Development and Planning Department (Planning) and speaking with local agencies and staff, SCJA/AECOM was guided on a field tour by QIN staff with expertise and experience about local access and field conditions along key stretches of the coast and the rivers. The field tour, which took place on September 7 and 8, 2016, allowed SCJA/AECOM to collect additional information about the conditions and uses of shoreline areas and to identify problem areas, such as landslides or places where flood hazards pose a threat to roads. This field tour provided an excellent baseline for understanding the natural environment and shoreline land uses within the Reservation. Examples of information collected during the field tour include vegetation communities within the SAA; areas affected by noxious weeds; areas of importance for salmonid habitat or hatcheries; important fishing areas; coastal erosion areas; important cultural sites; and areas potentially suitable for restoration or preservation.

2.3 Shoreline Mapping, Addressing Data Gaps, and Reach Identification

SCJ/AECOM mapped the SAAs in GIS using data provided by the QIN and other sources, as needed. The team then split the shoreline areas along the coast and in each river into smaller reaches for more detailed analysis. Additionally, new layers were created to address data gaps, which included floodplain or channel migration zone data for all streams and rivers, and a mapped coastal mean higher high water (MHHW) line. These layers were created using available Light Detection and Ranging (LiDAR) data and the National Oceanic and Atmospheric Administration's (NOAA's) coastal VDATUM tool or HEC-Ras software. The following subsections describe the specific methods employed to create the SAAs and reach breaks, which are shown on Figure 3, which is adapted from Digital Map A-2.

2.3.1 Riverine Shoreline

Quinault LiDAR survey data was used to generate the centerline of the seven rivers included in this study. The SAA includes the estimated 100-year floodplain of each river, plus an additional 200-foot extension beyond (landward of) the floodplain boundary. The 200-foot extension of the floodplains was intended to capture steep valley walls and terraces , which are closely connected with river functions. The 100-year floodplain data was not consistently available for all rivers. The following data sources were used or created to determine the floodplain or to provide a close approximation:

- Federal Emergency Management Agency FEMA modeled 100-year floodplain data – available for the Queets and Quinault Rivers
- Modeled 100-year floodplain[3] – applied to Raft River and Wreck Creek
- The Grays Harbor County Shoreline polygons were used to approximate the 100-year floodplain for the Salmon River, North Fork Raft River and Moclips River[4].

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[3] Floodplain data modelled by Chris Vondrasek using HEC-RAS software and 15-foot resolution LiDAR data obtained by the QIN in 2013.

[4] The Grays Harbor Couty polygons were Channel Migration Zones, which provide an approximation of the 100-year floodplain. They were created using the Washington Department of Ecology Channel Migration Potential (CHAMP) database.

2.3.2 Coastal Shoreline

The marine coastal shoreline within the Reservation was determined using Quinault LiDAR data, supplemented with 2012 NOAA LiDAR data as needed to fill in gaps. The coast line (MHHW line) was modeled based on elevation data using the NOAA VDATUM tool. To generate the full extent of the marine Shoreline Analysis Area (SAA), the MHHW elevation at the beach was used as a baseline. The eastern boundary was defined by measuring inland 800 feet from the MHHW mark. Additionally, the 800 foot distance was increased in certain locations as needed to capture the U.S. Highway 101 and State Route 109 rights-of-way. Along the southern coast the buffer was increased as needed to encompass a minimum of 300 feet of vegetated land surface inland from the beach.

2.3.3 Lake Shoreline

The Lake Quinault shoreline (the OHWM[5] of the Lake) was determined using a wetland inventory data set completed by the QIN in 2015. The SAA for the Lake along the southwest shoreline was extended from the OHWM landward for 200 feet for areas within the Reservation near Amanda Park to generate the Lake Quinault SAA (LQW). Uplands outside of the northern and southern shorelines of the Lake are not within the Reservation, and thus no Shoreline zone outside of the water surface is defined in those areas.

2.3.4 Identification of Reaches

Once all SAA boundaries were defined and mapped across the Reservation, shoreline areas for each water body were separated into smaller reaches for analysis (Table 2; Figure 2). Reaches for rivers were determined based on geographic features, artificial constraints (e.g. fish hatchery weir), and/or confluence with major tributaries. Reaches for the Pacific Coast were determined based on tidal influence, coastal segments between major drainages, and/or landscape-level features. Reaches for Lake Quinault were determined based on land use. Reaches for Lake Quinault include two segments outside the Reservation boundary that are not included within the SAA (the north and south shores), but they are still addressed to a limited degree in this plan, as is relevant to the Lake itself, which is wholly within the Reservation.

[5] OHWM = Ordinary High Water Mark

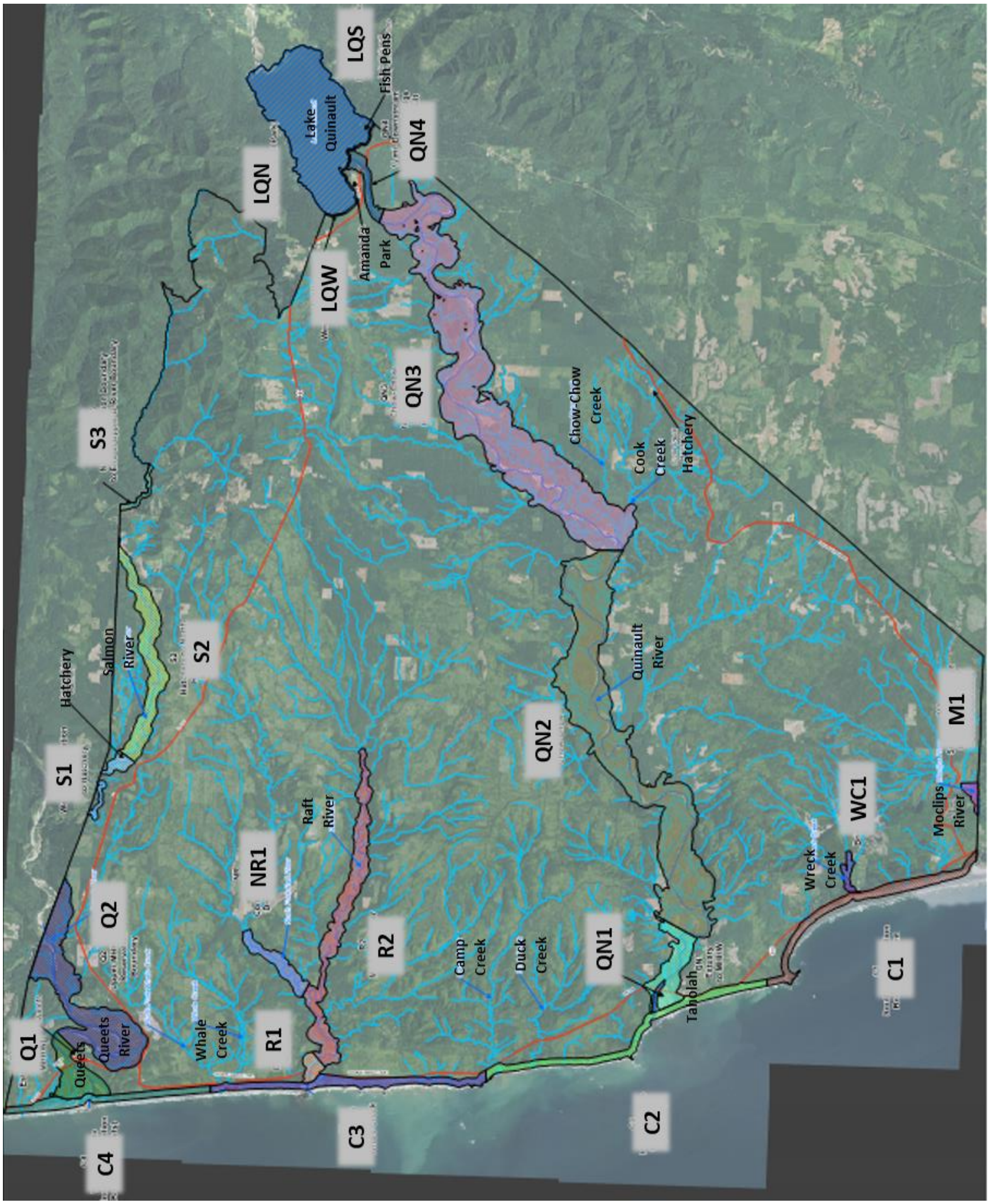

Figure 2. Shoreline Analysis Area Reaches (adapted from Digital Map A-2, Shoreline Assessment Areas)

Table 2. Shoreline Reaches for Analysis			
Water Body	Reach (Map Designation)	Location	Length[6] (miles)
Pacific Ocean	C1	Southern Reservation Boundary to Point Haynisisoos[7] (Moclips)	7.45
	C2	Point Haynisisoos to Pratt Cliffs (Taholah/Quinault)	8.09
	C3	Pratt Cliffs to Whale Creek (Raft)	7.33
	C4	Whale Creek to Northern Reservation Boundary (Queets)	4.94
Queets River	Q1	Estuary (Mouth to Upper MHHW)	2.34
	Q2	Upper MHHW to Reservation Boundary	6.32
Salmon River	S1	North Reservation Boundary to Hatchery	2.65
	S2	Hatchery to North Reservation Boundary	7.66
	S3	North Reservation Boundary to End of Upper D-River Boundary	1.69
N. Fork Raft	NR	Raft River Confluence to Upper D-River Boundary	3.06
Raft River	R1	Estuary (Mouth to MHHW)	1.19
	R2	MHHW to Upper D-River Boundary	11.90
Quinault River	QN1	Estuary (Mouth to MHHW)	2.57
	QN2	MHHW to Chow-Chow	14.75
	QN3	Chow-Chow to Narrows ¾ Mile Downstream of U.S. Highway 101 Bridge	15.41
	QN4	Narrows ¾-Mile Downstream of U.S. Highway 101 Bridge to Lake Quinault Outflow	1.72
Wreck Creek	WC1	State Route 109 Bridge to Upper Boundary	0.69
Moclips River	M1	Southern Reservation Boundary to Upper D-River Boundary	1.04
Lake Quinault	LQN	North Shore (Olympic National Park)	n/c
	LQS	South Shore (Private and National Forest Lands)	n/c
	LQW	West Shore (Amanda Park Area)	2.63

n/c = not calculated; outside the Reservation boundary.

2.4 DATA ANALYSIS

Data analysis included an interpretation of findings regarding historical conditions and disturbances of regional processes. This information was used to determine which shoreline factors are controllable at the local level, versus those that are the result of a historical alteration or regional processes that are beyond local control, yet important to the management of local shorelines. For example, sea-level change impacts in Taholah are beyond the control of the QIN; thus, they require response planning rather than avoidance planning.

[6] Length refers to centerline for linear waters, coastline for the ocean, and shoreline for Lake Quinault.

[7] Point Haynisisoos is the QIN name for what used to be called Point Grenville.

However, water quality from gravel mining activities adjacent to fish-bearing steams or hatchery areas may benefit from reach-specific planning to minimize impacts before they have negative effects.

Resource data available in GIS format were “clipped”[8] to each shoreline assessment reach and summarized in data tables to highlight predominant factors relevant to each reach (e.g. soils, vegetation, important habitats, and others). For the shoreline use analysis, data for land use, zoning, and ownership were used at a broad scale to determine general information about assumed or expected present and future land uses within the SAA. Recent aerial photos provided additional information about current land use, and were useful in identifying infrastructure, including buildings, and other types of development. Notes and photographs from the field tour provided more site-specific information about shoreline use for various reaches of the SAA. GIS data showing culvert locations provided information on possible locations of fish passage barriers, culvert maintenance, and/or replacement.

Information was also obtained from available documents including, but not limited to the neighboring county SMPs (Grays Harbor County and Jefferson County), the QIN Forest Management Plan, QIN Title 48 (Land Use and Development Code), coastal reach assessment photos and maps prepared by Kamiak Ridge LLC, and the Environmental Assessment for the Taholah Village Relocation Master Plan.

2.5 REGULATORY CONTEXT

The QIN regulations and policy documents listed below were consulted and reviewed during the Shoreline assessment process to ensure that work was properly focused to support and inform existing regulations and policy.

QIN Title 45: "QIN Shoreline Management Code of 1993" was written in the early 1990s, but was not formally adopted.

QIN Title 48: Land Use and Development Code (2013) is the primary permitting and review regulation for the Reservation.

QIN Title 52: Beach Lands Protection (2008) clarifies and defines the extent of QIN sovereignty along the Pacific coastline, and defines activities that are allowed versus not allowed on the beach.

QIN Title 61: Natural Resource Management regulation is used by the Quinault Department of Natural Resources (QDNR) to manage QIN forests, fish and wildlife habitat, and mineral lands.

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[8] “Clipping” refers to the process of extaracting a smaller section of a GIS map layer from the whole, which allows analysis of acreage and other characterstics of the smaller target area.

Federal regulations potentially applied within QIN:

- Endangered Species Act (USFWS)
- Anadromous Fish Conservation Act (USFWS)
- Migratory Bird Treaty Act (USFWS)
- Clean Water Act (EPA, ACOE)
- National Environmental Policy Act (EPA)
- Clean Air Act (EPA)
- Marine Mammal Protection Act (NOAA Fisheries)
- Coastal Zone Management Act (NOAA Office for Coastal Management)
- National Historic Preservation Act (**Native American Affairs** [Department of Commerce] oversees the Federal Advisory Council on Historic Preservation for Native American initiatives)

3. ECOSYSTEM-WIDE CHARACTERIZATION

3.1 REGIONAL CONTEXT

The Reservation (about 208,150 acres) is located along the western coast of the Olympic Peninsula, extending east in a semi-triangular shape with the eastern apex including the water surface to the Ordinary High Water Mark (OHWM) at Lake Quinault. The western boundary of the Reservation is defined by low tide along the Pacific Coast, starting just north of Moclips, Washington and extending over 23 miles to the Reservation's northwest corner, located about 2 highway miles north of the Queets River Bridge. Much of the Reservation is in Grays Harbor County, but some northern portions are in Jefferson County.

The great majority of the Reservation is relatively low relief, having been formed from repeated flood deposits emanating from the Olympic Mountains to the east. The surface of Lake Quinault at the eastern end of the Reservation is about 184 feet elevation. Taholah, the center of government for the QIN, is located near sea level at the mouth of the Quinault River about 20 miles to the southwest. Thus, the overall slope of the Quinault River is less than 1 percent. The highest elevation areas within the Reservation are located on a series of mountain ridges in the northeastern corner, north of U.S. Highway 101. The ridgetop Salmon River Lookout in that area is at just over 2,600 feet elevation. However, the great majority of the Reservation is at less than 1,000 feet elevation.

3.2 WATERSHED OVERVIEW

The Reservation falls entirely within the Queets/Quinault WRIA 21 (Water Resource Inventory Area 21), one of 62 large watershed management units in the state (Figure 3). The Queets and Quinault are the two largest rivers in WRIA 21, with headwaters high up in the Olympic Range. The basin collects 100 to 200 inches of rainfall per year – the highest annual rainfall total in the Continental U.S. outside of Alaska. As a result, much of the Reservation is covered by a temperate rain forest, dominated by a wide range of evergreen tree species.

The Queets and Quinault River systems have been studied and compared many times, due to their importance in forming an understanding of these unique Olympic Coastal rainforest ecosystems. The critical difference between the two systems is due to the lower Quinault being so greatly affected by Lake Quinault, located about midway in the Quinault basin. It effectively halts and reorganizes flows between the upper and lower reaches.

O'Connor et al, 2003 provides an excellent comparison of the Queets and Quinault basin systems; the upper Quinault is characterized by a wide floodplain containing many log jams and debris flows, receiving coarse woody debris and sediment from the steep headwaters in the upper Olympic Mountains, while the lower sections of the Quinault below

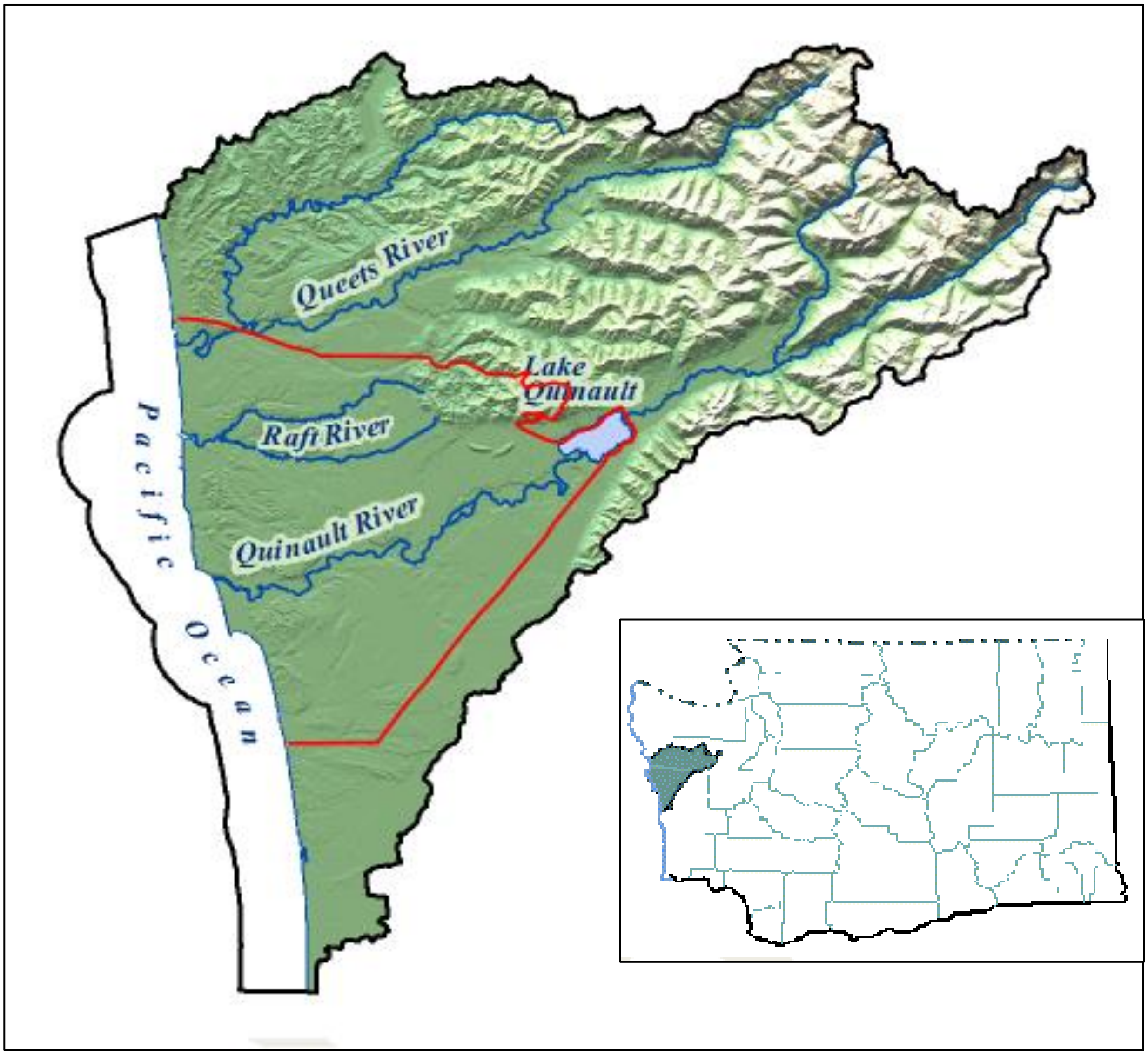

Figure 3. Reservation Boundary within WRIA 21 (Adapted from Ecology WRIA map).

the Lake are flatter, but with a narrower floodplain and active channel, and with less coarse woody debris. O'Connor et al, describes the Queets as being a mixture of attributes of both the upper and low Quinault.

These two primary river systems perform critical ecosystem functions in the Olympic Region, and downstream reaches flow through the heart of the QIN Lands. Brief descriptions of these and various other basins within the Reservation, starting at the northern end and continuing to the south, are provided in the sections that follow (Figure 4).

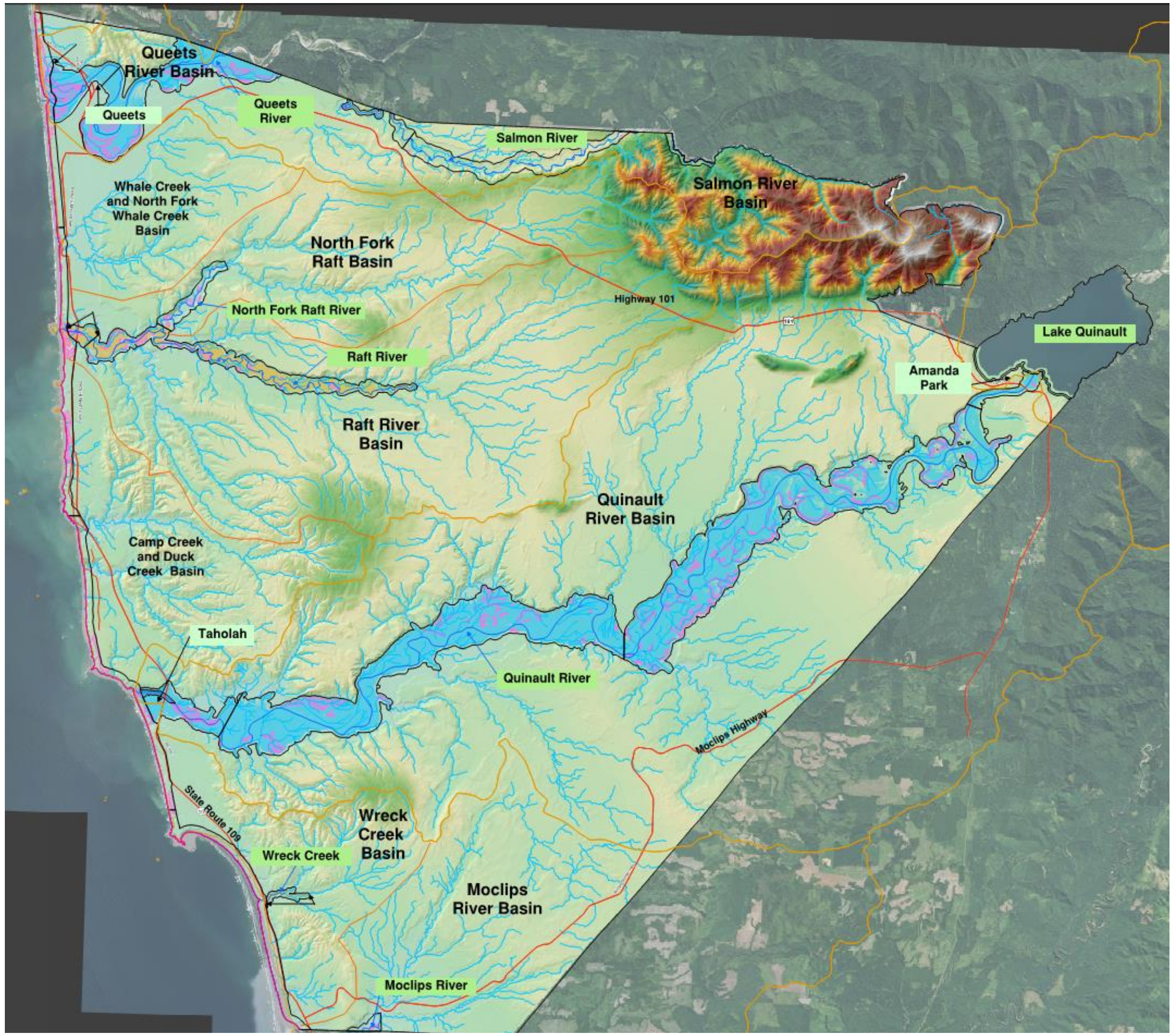

Figure 4. Reservation Basins (adapted from Digital Map A-3) showing the Watersheds for the Shoreline Analysis Areas

3.2.1 Queets (including Salmon) River Basin

The Queets River Basin is the largest sub-basin in WRIA 21. It covers over 200 square miles within WRIA 21 and is over 50 miles long. However, only about 15% of the greater Queets basin (about 30 square miles) is within the Reservation, and most of that area is within its Salmon River sub-basin, running along the northeast Reservation boundary. The portions of the Queets and Salmon Rivers within the Reservation support a prolific commercial salmon fishery (including a private QIN Hatchery on the Salmon River), and the Queets estuary at the Pacific Coast is complex, unique, and highly productive. Both the fishery and the estuary are very important resources for the QIN.

3.2.2 Whale Creek and North Fork Whale Creek Basins

The smaller, combined Whale Creek and North Fork Whale Creek basin (about 14.3 square miles) is south of the Queets River near the Pacific Coast, with the most upstream, eastern end of the basin only 5 miles from the coast. Moses Prairie, one of several large and highly valued fen wetland systems within the Reservation, is associated with the North Fork of Whale Creek. State databases do not document salmonid presence in these two small systems, but information from Tribal staff indicates that there may be salmonids present. There is no obvious barrier to fish passage at high tide; however, the drainage channel across the beach is narrow and incised at low tide, which may restrict fish access to some degree.

3.2.3 Raft River and North Raft River Basins

The Raft River and North Fork Raft basins (combined area about 79 square miles) are directly south of the Queets/Salmon basin and southeast of the Whale Creek basin. All headwaters for these two sub-basins are entirely within the QIN Reservation, with the far eastern end of the Raft basin being about 15 miles from the Coast. These rivers support salmon runs, but are not typically commercially fished, as compared to the Queets and Quinault.

3.2.4 Camp Creek and Duck Creek Basins

The smaller, combined Camp/Duck Creek basin (about 21 square miles) is located southwest of the Raft River system, with the farthest upstream end of the basin being about 6 miles from the Coast. Like Whale Creek, state databases do not document salmonid presence in these two small systems, but there may be salmonids present.

3.2.5 Quinault River Basin

The Quinault River Basin is the second largest riverine system in WRIA 21. It covers approximately 188 square miles and is 69 miles long. The Quinault is the primary river system within the Reservation. About 70% (about 138 square miles) of the Basin (including Lake Quinault, which covers about 5.8 square miles) is in the Reservation. The Quinault River supports a prolific commercial salmon fishery, and a side channel at Cook Creek supports a

USFWS Hatchery. Taholah, the Quinault government center, is located at the mouth of the Quinault, on low-lying lands south of the River. Plans to move the village to higher ground to the southeast are in progress, to avoid problems associated with rising sea level and potential tsunami impacts. The Quinault fishery and Tribal center of government are critically important QIN resources.

3.2.6 Wreck Creek Basin

The small Wreck Creek basin is near the coast, south of the Quinault River and Point Haynisisoos. This basin includes Point Haynisisoos, an important cultural heritage area highly valued by the QIN. The basin covers about 15 square miles, which includes many small sub-basins, some of which drain directly to the bluff around Point Haynisisoos rather than to the Creek. The distance from the mouth of Wreck Creek to the upper extent of the basin is about 3.75 miles. State, databases do not document salmonid presence in this small system, but there may be salmonids present.

3.2.7 Moclips River (including North Fork Moclips) Basin

The Moclips River basin runs along the southeastern Reservation boundary, with the mouth and estuarine portions of the River located just south of the Reservation's southwest corner boundary. This basin is about 36 square miles, including the larger North Fork sub-basin. About 70% of the basin is inside of the Reservation, but the mouth of the Moclips and its estuary areas (about 2 to 3 river miles) are outside of the Reservation boundary. An additional 16 to 17 river miles extend into Quinault lands. The Moclips is a salmon bearing system, smaller than the Queets or Quinault, but still an important local fishery.

3.2.8 Coastal Terrain

Ultimately, the basins and sub-basins described above drain to the Pacific Ocean at the coast, mostly from large riverine/estuarine outlets, but also from several smaller creek and localized outlets. Some of these drainages are very small seeps, which drain only a mile or so to the marine bluffs, forming weak layers in the bluff faces, which sometimes cause soils and rock to slide or slump to the beach.

The nearshore environment along the coast is mostly formed at toe slope of steep bluff faces with occasional headlands and islands, broken only by periodic estuaries, which form where rivers and streams cut down through the headlands and flow into the ocean. However, the southern coastal zone from Point Haynisisoos to Moclips and beyond forms a broader, flatter beach – a reflection of changes to geology in this area (more on this in Section 3.3).

3.3 GEOLOGY, TOPOGRAPHY AND TSUNAMI HAZARD

Geology maps converted to GIS format are only available at 1:100,000 scale for the Reservation (Digital Map A-5: Geology, Geohazards and Tsunami Inundation). This level of mapping provides only very generalized geology information, and thus has only minor utility for detailed planning purposes. For this reason, the figures about geology and discussion in the sections below provide more detailed geology mapping information when available. Small subareas of the Reservation are mapped at more detailed scales, which provides access to more detailed local geology information; unfortunately, these more detailed geology maps are not yet available in GIS format.

The great majority of the Reservation is sandstone and siltstone bedrock overlaid by an ancient glacial outwash alluvial floodplain, created by flood deposits washing down onto the western coastal plain from the high elevation, glaciated regions of the Olympia Range (Figure 5). Eastern portions of the Olympic Mountains are 8,000 to 10,000 feet in elevation, huge wrinkles

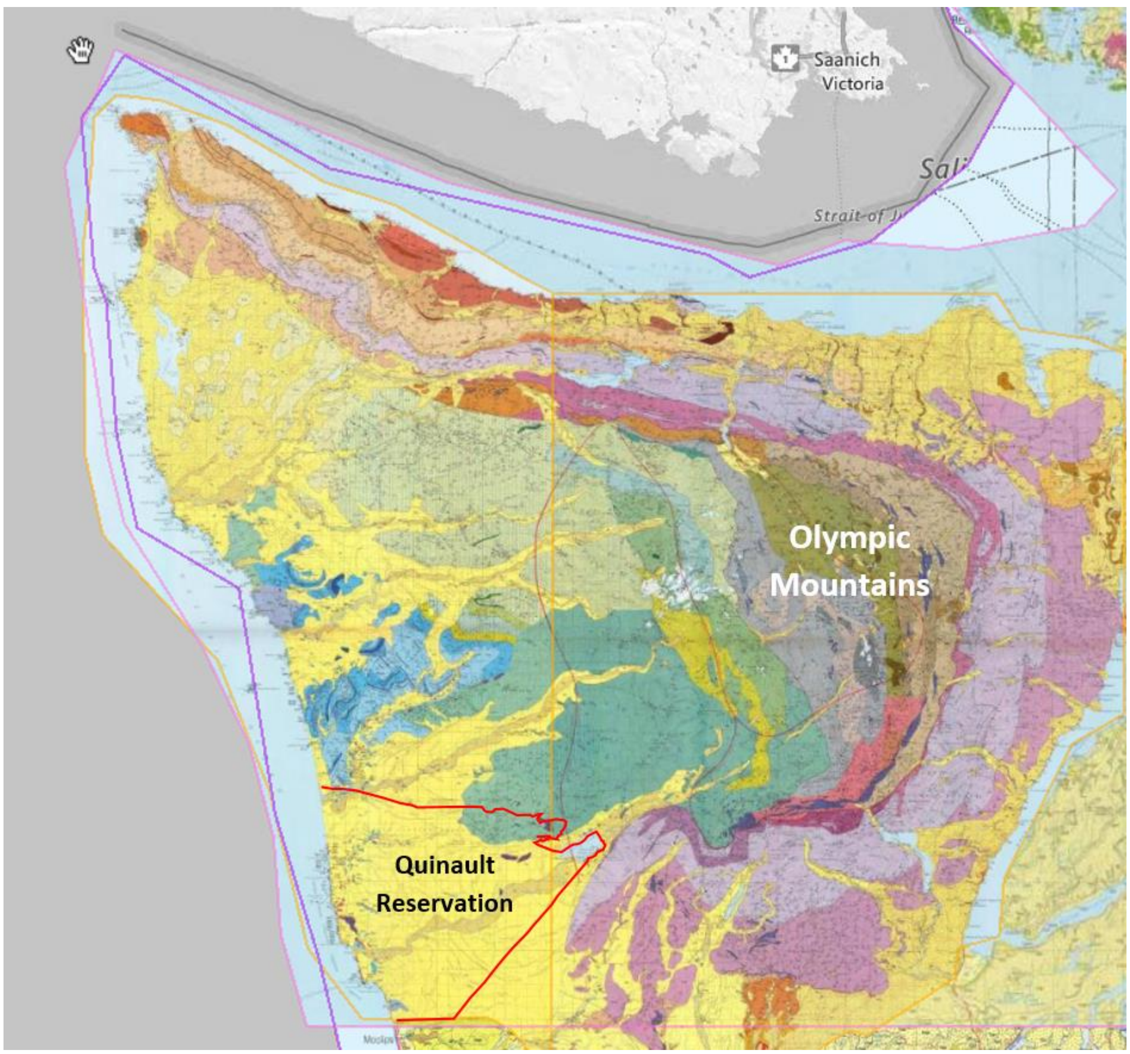

Figure 5. Olympic Peninsula Geology (adapted from USGS 1:125,000 scale map), inserting Reservation boundary. Yellow within the Reservation is glacial outwash flood deposits.

in the rock formed by plate tectonic forces pushing and piling overlapping layers of coastal rocks over the surface of the incoming San Juan de Fuca plate to form horse-shoe shaped curves of metamorphosed sedimentary rocks (called the Crescent Formation), with lava flows extruded around the weaker, cracked eastern perimeter. The Crescent Formation is the headwater source for the Quinault and Queets Rivers on the Reservation.

West of the Olympic Mountains, relief is low across the broad floodplain that forms the Reservation surface. Elevation across most of the Reservation ranges between sea level and less than 600 feet. In a few places on the alluvial plain and along the coast, older, resistant uplifted bedrock surfaces are exposed above the flood deposits. The buried bedrock units are only exposed along eroded river and creek channels and along the coast. Exposed bedrock cliffs are common in areas along the Coast between Queets and Point Haynisisoos.

Glacial outwash flood deposits and glacial till layers overlay the bedrock across much of the Reservation (Figure 6), a result of ancient alpine glacial ice sheets that expanded out from the Olympic Mountains during past Ice Ages. The weight of the glaciers compacted underlying

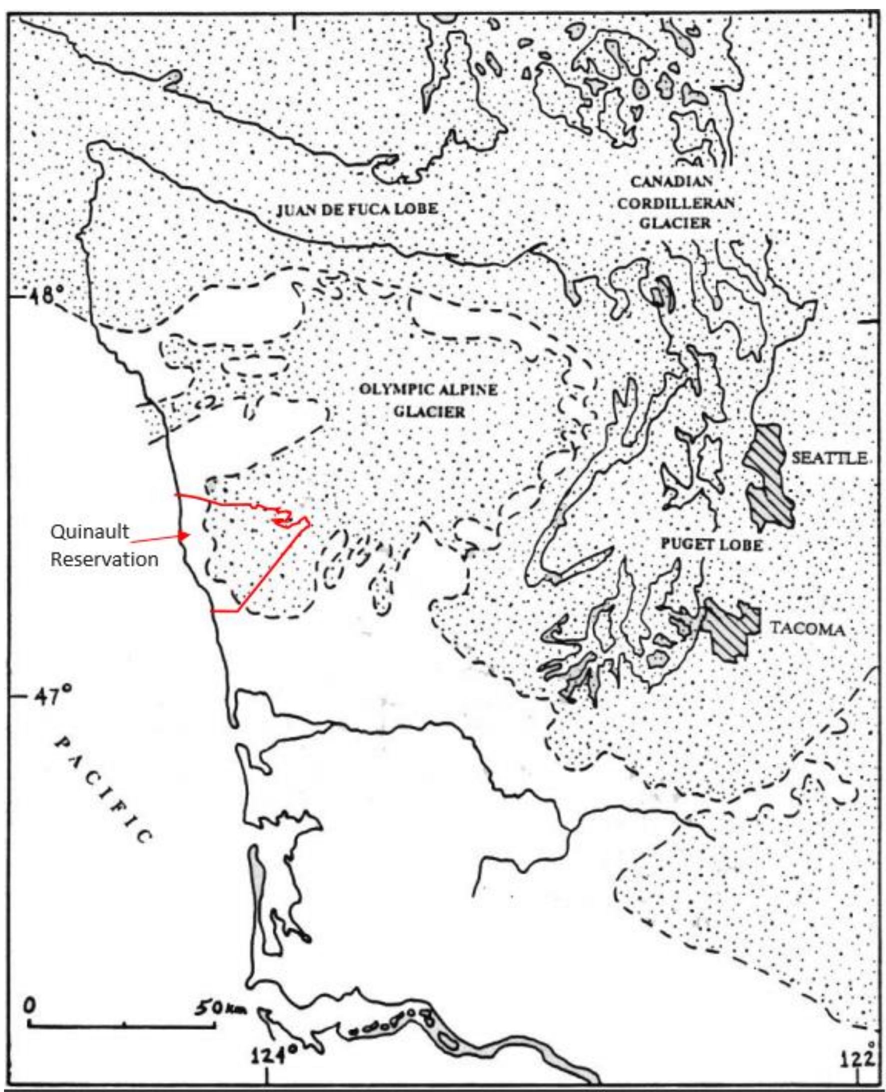

Figure 6. Showing relative location of Reservation in relation to past glacial impacts on the Olympic Peninsula. (Redrawn by Shalk and Yesner from Armstrong et al., 1965.)

sediment and sediment layers within the glacier to create dense, relatively impermeable substrates.

Surficial geology is mostly gravelly glacial outwash – water laid deposits of various depths from post-glacial flood events (Figure 7, bright yellow map unit; Appendix I); but the glacial outwash overlays compact, semi-impermeable glacial drift and glacial till across much of the Reservation. The outwash layers are mapped as being thicker in the eastern portions of the Reservation – a huge alluvial fan formed from outwash floods emanating from the mountains to the east. This indicates that more water will infiltrate and drain across subsurface layers in the eastern parts of the Reservation.

The only high-relief, mountainous area on the Reservation is in the far northeast portion – less than 25 acres – a small area in the Olympic Range, with ridge top elevations of over 2,600 feet (Figure 7, green map unit in the northeast; Appendix I). The bedrock in this area is a mixture of partially metamorphosed sandstone, siltstone and conglomerate (the Hoh Formation), common along the western slope of the Olympic Mountains. Seasonal stormwater will drain from this area more rapidly than on the flatter topography more common across most of the Reservation.

At the opposite end of the Reservation along the western coast, the exposed bedrock bluffs, common in the southern portion of the coast have bedrock bases overlaid with densic glacial till and outwash sediment caps (Figure 7, purple, blue and red map units; Appendix I). Some of the bedrock units are tectonic breccia (brittle metamorphosed rock that forms as the plate subducts at the coast), but also sandstones and siltstones – some of them fossil-bearing. The northern coast bluffs are composed of cemented glacial till layers, which are more erodible and prone to sluffing than bedrock bluffs to the south.

There are small areas within the Reservation and along the Coast where lava has extruded onto the surface (Figure 7, dark purple map units; Appendix I), usually accompanied by sandstones and siltstones, which have been fractured or partially metamorphosed by the lava, creating fused conglomerates. At the beach, the extruded lava formed pillow basalts in some areas, but it has also created resistant headlands and islands. Point Haynisisoos and its associated islands are mostly composed of an ancient lava flow and associated mélange conglomerate rocks, but also includes areas of less resistant sandstone, which erodes more easily.

The glacial outwash surface deposits and glacial till substrate control hydrology on the Reservation to a great degree. Soils in upland areas are relatively shallow, and seasonal rainfall drains only a few feet into the ground before hitting dense till substrate or bedrock, then being forced to drain horizontally downslope.

Detailed geology descriptions defining the type of bedrock or geologic deposit represented by each map unit are provided in the Appendices, and are discussed in Chapter 4 for Individual Reaches.

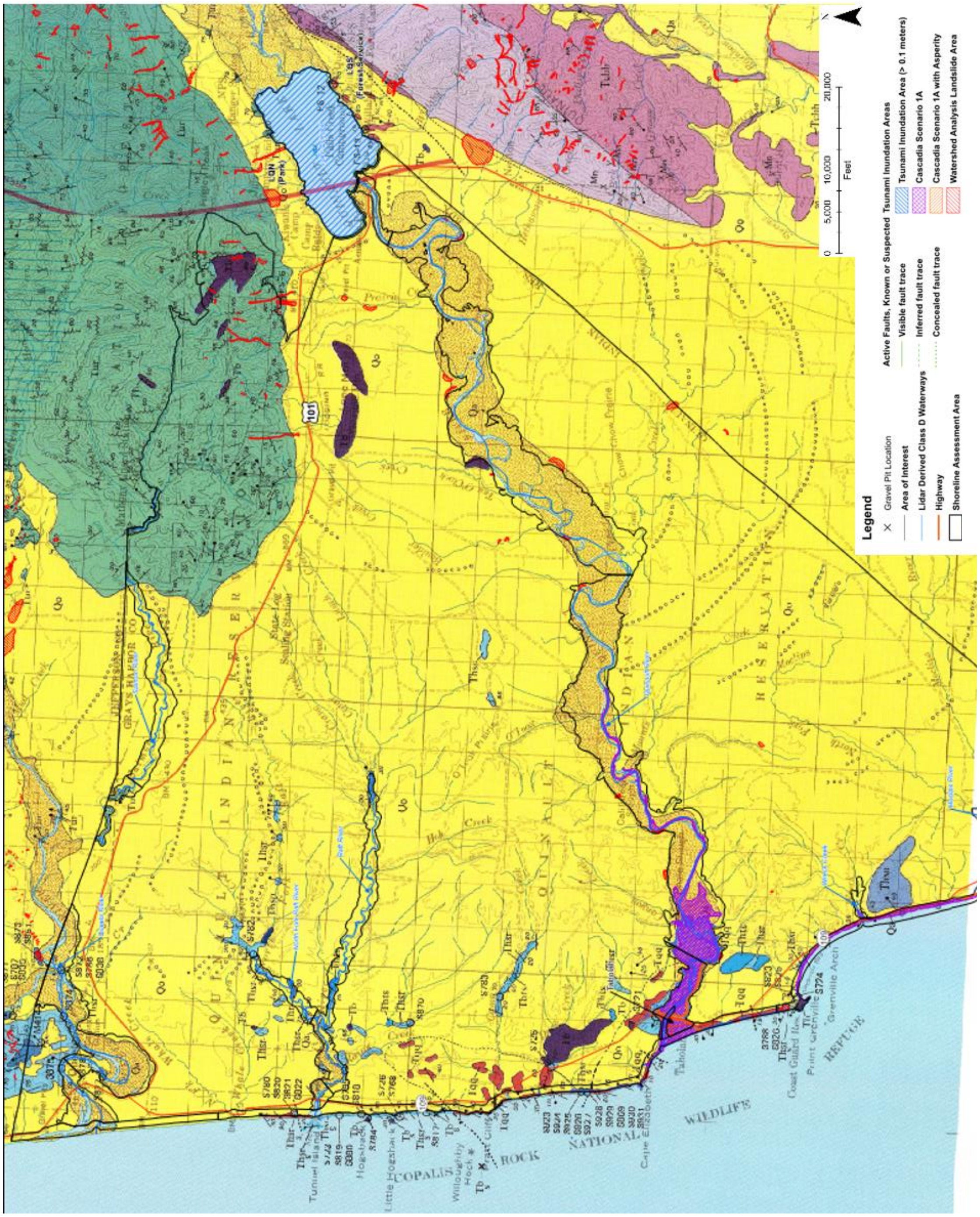

Figure 7. 1:125,000 scale Geology of the Reservation (smaller scale than the 1:100k scale Digital Geology Map A-5), showing glacial outwash and drift surfaces dominant on the Reservation (bright yellow).

The Quinault coast has been affected from past tsunami events; buried forests in coastal estuaries provide evidence of repeated submergence associated with subduction earthquakes (Figure 8). Large scale digital maps (Digital Map A-5, Geology, Geohazards and Tsunami Inundation) provided with this report display results of various tsunami models downloaded from Washington Department of Natural Resources (WaDNR) GIS databases, showing extent and location of flooding from tsunamis with various wave heights.

Two tsunami models were applied in 2010 along certain sections of the Washington Coast by Washington State Department of Natural Resources (WaDNR) geologists. In 2015, WaDNR provided a site-specific tsunami model update for the areas around Taholah and Queets. These models were variations of "Cascadia Scenario 1A"[9], which was based on a Magnitude 9.1 Cascadia subduction zone earthquake, and assumes several other variable event characteristics,

Figure 8. Showing buried forest from past tsunami event along the Quinault coast near Raft River.

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[9] Cascadia scenario 1A: Tsunami hazard map of the southern Washington coast—Modeled tsunami inundation from a Cascadia subduction zone earthquake, by T. J. Walsh, C. G. Caruthers, A. C. Heinitz, E. P. Myers III, A. M. Baptista, G. B. Erdakos, and R. A. Kamphaus. 2000. 26 x 52 color sheet, scale 1:100,000, with 12 p. text.

DESCRIPTION Cascadia scenario 1A are areas inundated by a **moderately high** runup from the modeled Cascadia subduction zone tsunami.

Cascadia scenario 1A with asperity: Tsunami hazard map of the southern Washington coast—Modeled tsunami inundation from a Cascadia subduction zone earthquake, by T. J. Walsh, C. G. Caruthers, A. C. Heinitz, E. P. Myers III, A. M. Baptista, G. B. Erdakos, and R.A. Kamphaus. 2000. 26 x 52 color sheet, scale 1:100,000, with 12 p. text.

DESCRIPTION Cascadia scenario 1A with asperity are areas inundated by a **high** runup from the modeled Cascadia subduction zone tsunami.

such as rupture length and width; uplift at the fault line; and land subsidence during ground shaking. The model outcomes were mapped over LiDAR topography, and indicates impacts from waves of 30 to 40 feet height arriving at the coast 30 to 60 minutes after the earthquake.

For areas along the coast that were not included in the modeling – such as the Quinault coast between Cape Elizabeth and Queets – the 25-ft. contour is generally used to represent the height of potential tsunami inundation, with vertical resolution error of 2 to 6 meters (about 6 to 18 feet). However, more recent models and evidence from other events indicate potential for larger waves along the Coast, dependent on the magnitude and location of the earthquake. Newer models by Myers and Baptista (2016) funded by the National Tsunami Hazard Mitigation Program displayed in video format show wave heights as high as 20 meters (about 60 feet)[10].

The 2016 Quinault Tribal Hazards Mitigation Plan provides a comprehensive assessment of risks from natural hazards – including tsunami and earthquake hazards -- and outlines the QIN plan for mitigating those risks.

3.4 The Reservation Key Species and Habitats

Reservation includes a wide range of habitats and species. Portions of two of the largest riverine ecosystems in the Olympics (Queets and Quinault) occur within the Reservation's boundaries. Both are relatively natural river systems with minimal shoreline armoring and few floodplain controls. These systems include broad, complex, active floodplains and significant changes in seasonal habitat conditions, which create constantly changing niches and rich "edge habitat" conditions.

Salmonids are likely the most culturally important species to the QIN, but other animals – such as cougar, bear, and elk – are actively managed to ensure that hunting for subsistence as well as guided hunts are properly documented and controlled to ensure long term sustainability of local populations.

Offshore to the west, the Copalis National Wildlife Refuge includes many small islands – remnants of eroded headlands – which harbor nesting seabirds and sea mammals that also use the Quinault shorelines and beaches for nesting, resting, and feeding habitat.

Lake Quinault forms the eastern extent of the Reservation, and is situated halfway down the Quinault watershed, where it forms a barrier between the upper and lower reaches of the Quinault River. It is the second largest freshwater lake along the west flank of the Olympic Peninsula and is surrounded to the north, east, and south by single-family homes, which back up into relatively undeveloped forests and parklands.

[10] Video of updated model outcomes: https://www.youtube.com/watch?v=YhjsAjZQZeg.

This combination of conditions ranging from saltwater to freshwater; from beaches to mountains; and from large rivers to large lakes makes the Reservation one of the richest and most diverse ecosystems on the Olympic Peninsula.

3.4.1 Estuarine and Marine Habitats

Key habitats associated with estuarine and nearshore marine habitats in the Reservation are described below.

Marine Coastal Bluffs

The great majority of the Reservation coastline is dominated by bedrock-based marine bluffs behind broad beaches, with exceptions at major river and creek outflows, where estuary conditions dominate. North of the Queets River estuary, the top of bluff ranges from 40 to 60 feet elevation – the smallest marine bluffs on the Reservation aside from the far southern extents near Moclips. The bluffs south of the Queets range from 60 to 100 feet elevation down to the Whale Creek outlet. South of Whale Creek to Camp Creek, the top of bluff elevation ranges between 100 and 120 feet, except at the Raft River outlet. The eroded remnant headlands and islands out in the Copalis National Wildlife Refuge off the coast in that area range from 20 feet elevation to as high as 138 feet elevation.

In the area from Camp Creek to Duck Creek, the top of bluff ranges from 120 to 160 feet elevation, except at the stream outlets. Continuing to the south, the top of bluff all the way to Cape Elizabeth, and along the north side of the outlet of the Quinault River is over 200 feet elevation – the highest on the Reservation. Taholah is located south of the River at that location, on lowlands at less than 20 feet elevation which are essentially part of the Quinault's outlet alluvial fan. Within a mile to the south, the marine bluff is again over 100 feet elevation all the way to Wreck Creek, although south of Point Haynisisoos, the bluff gradually moves back from the beach and becomes more sloped. From Wreck Creek to the southern Reservation boundary near Moclips, the uplands to the east are mostly highly dissected and sloped back from the shore, but still are over 100 to 300 feet elevation at top of slope.

Most vegetation along the coast is at the top of the bluff, except in areas where drainages cut through the uplands and flow out across the beaches, forming estuaries and small lagoons. These outflow areas range in size from a few hundred square feet to many acres. The bluffs as well as the many offshore islands provide feeding, nesting and resting habitat for a variety of birds, ranging from swallows to pelagic species – seagulls, cormorants, pelicans, and others.

The occasional vegetated areas in the lower sections of the bluffs are often a result of landslides, which stabilize temporarily and persist long enough to support plants. These areas also provide sediment and coarse wood to the beaches over time. The plants in these lower, relatively unstable landslide surfaces provide habitat, but also perform other functions, such as sediment capture and filtration, and therefore provide for some water quality control. They also provide shade and microhabitats for small mammals, insects, and birds.

Beaches

Beaches on the Reservation are gravel dominated in the areas with steep, tall feeder bluffs, but sands tend to accumulate along the shoreline south of river and stream outlets, reflecting the predominant southerly flow direction of the California Current system during summer months along the Washington Coast (adapted from Hickey and Banas, 2003, in Skewgar and Pearson, 2011). Sands also tend to collect in areas with less resistant, sloped bluffs, which contribute fine sediment and less gravel to the beach – such as the areas south of Point Haynisisoos. The broad sandy beach in that area is actively mixed, moved, and resorted during almost every tide.

Sand lance and surf smelt are documented as spawning in certain areas along the northern Quinault coastline. The locations of these spawning areas will be discussed in more detail in the individual Reach Descriptions below in Chapter 4. These species spawn in the intertidal zone where mixed sand and gravel accumulates, and are not found in areas with coarser, more gravel-dominated substrate. The mapped locations of these spawning areas correspond with outflows from rivers and creeks, usually extending southerly from the outflows, as is common along the Washington Coast[11]. Two spawning areas are mapped south of the Queets River; one area south of Whale Creek; one area south of the Raft; several areas between Cape Elizabeth and Taholah; two areas south of the Quinault; and one area at the tip of Point Haynisisoos. Protecting these forage fish spawning areas directly protects salmon, as they are a key food source for salmon, as well as for marine birds, and many other fish species.

Shellfish also prefer mixed gravelly-sandy substrates; thus, are expected to occur in the same general areas as the forage fish spawning zone, and in outer estuaries. Shellfish and other sand-dwelling invertebrates form the base of the food chain in beach areas, providing food for shorebirds and mammals.

Estuaries

Estuaries and tidal marshes are critical ecosystems for salmonids. They provide safe rearing and feeding habitat for certain species, and places to hide for migrating fish. These complex systems are the most ecologically active habitat along the coast, due to providing so many different niches and edge habitats: open, ponded water; moving water; a range of salinities; mudflats; sand and gravel bars; vegetated herbaceous areas; shrub-dominated and tree dominated islands; and perimeter habitats. Foraging options for migrating shorebirds are endless, and beaches near the river mouths are commonly used by marine mammals, partly for resting, but also for their proximity to nearby feeding areas for fish, a preferred food source.

[11] Mapped locations of sand lance and surfsemlt spawning areas: http://wdfw.maps.arcgis.com/home/item.html?id=19b8f74e2d41470cbd80b1af8dedd6b3

According to Marine vegetation surveys carried out by the WaDNR, (Berry et al 2001), there are no eelgrass areas along the Quinault coast, but varieties of kelp and other macro algae are abundant.

Rocky Shores and Nearshore Pelagic

A rocky shore habitat is a coastal, intertidal area where solid rock is dominant on the beach. Nearshore pelagic habitat extends about three miles out from the rocky shore; thus, is not within the Reservation, but is directly adjacent. Both rocky shores and nearshore pelagic habitats are combined in this discussion, mainly because the offshore islands in the nearshore pelagic habitat are tied closely with the rocky shores habitat.

Rocky shore can take the form of solid bedrock or loose boulders, but only includes minimal amounts of fine sediments (sands). The northern Olympic Peninsula coast to Point Haynisisoos is generally described as being dominated by rocky shores. South of Point Haynisisoos, the beaches are sand dominated and much wider with no headlands or steep marine bluffs.

As mentioned above, there are some sandy areas along the northern shoreline, mostly at river and stream outlets, but the dominant substrate at the beach is cobbles and gravels. This is a result of the coastal bluffs almost constantly calving in minor and major landslides, depositing glacial gravels and bedrock at the beach.

Headlands at the beach have eroded over millennia to form sculptured arches and islands, some nearshore and some far out in the water well offshore. The offshore islands are almost all nurseries for some type of pelagic seabird – cormorants, terns, seagull and others – which also make common use of the rocky shoreline within the Reservation for feeding and resting, and even sometimes nesting habitat. The rocky shores habitat and structure also provides excellent opportunities for growth of macro algae, anchored in the bedrock offshore and fed around the islands by nutrients from guano and other seabird refuse. Kelp and other macro algae are commonly mapped along the rocky northern shoreline. These narrow beaches with minimal human impacts are also popular haul out areas for marine mammals.

3.4.2 Freshwater Habitats

Freshwater Habitats include rivers, streams, floodplains of those systems, and associated vegetated riparian systems – wetlands, forests, and grasslands.

Like estuaries, these freshwater systems contain many niches and edge habitats – a wide range of intertwined water, wetland and upland environments. They provide for storage and treatment of nutrients and floodwater; they regulate water temperature; they provide gravelly substrates critical to spawning, and support populations of invertebrates, which form the base of the food chain. Secondary channels provide for off-channel resting and feeding habitats, as well as storage of detritus and other nutrients critical to support of a wide range of species. Thus, these freshwater riparian systems are critical for the survival of the many species of amphibians, mammals, rodents, and salmonids that are abundant in Reservation systems –

particularly in the large Queets and Quinault River systems, but also in the comparatively smaller river systems, such as the Raft and Moclips.

The wetlands in and associated with the river and stream floodplains also provide for water quality treatment; water storage and critical wildlife habitat for many species which depend on water for some part of their life cycle.

3.4.3 Documented Animal Species

Per the 2003 to 2013 QDNR Forest Management Plan, Appendix 2.5-A[12]: "*Of the eight fish species of special concern on the Reservation, five are species fished commercially and are managed for this commercial fishery. This management includes annual estimates of spawner escapements, and for some species, smolt outmigration investigations. Spawner escapements are calculated annually for coho, steelhead, sockeye, chum (Quinault River only), and chinook. Pink salmon, cutthroat and native char are not subject to targeted commercial fisheries, but are occasionally observed in these fisheries. In addition, regulated sport fisheries exist on coho, chinook steelhead, and cutthroat. Native char were occasionally harvested in the sport fishery, but the opportunity to harvest native char was ended upon the listing of bull trout as threatened under the Endangered Species Act.*"

There are three hatchery facilities currently operating within the Reservation: The Quinault National Fish Hatchery on Cook Creek (coho, chinook, chum, steelhead); the Quinault Salmon River Hatchery (coho, steelhead); and the fish pen operation at Lake Quinault (chinook, steelhead). The Queets, Quinault and Moclips Rivers are stocked with hatchery fish, but also support native fish stocks. No other Rivers on the Reservation are stocked, aside from occasional stocking of the Raft with steelhead. More recent information about Quinault fishery records are available through QDNR.

Species expected to occur within or near the Reservation are listed in in public domain databases. Lists of those species are provided in the Appendices in Tables A-27 and A-28. Table A-27 (adapted from the Washington State WRIA database) lists the various salmonid species that are believed to be present in various Reservation rivers. Table A-28 (adapted from the Washington State Department of Fish and Wildlife Habitats and Species database) lists all animal species believed to be present in Grays Harbor County, which is presumed to be representative of species present within in the Reservation.

3.4.4 Documented Plant Species

Rare plant species data is available through public domain databases and is provided in the Appendices. Table A-29 (adapted from the Washington State Department of Natural Resources Natural Heritage Program) is a list of rare plants found in Grays Harbor County, some of which

[12] This data from 2003 is the most recent information about fisheries management and data made available for this report.

may occur within the Reservation. Table A-30 is a list of miscellaneous species documented by Jeff Walker (AECOM Botanist) during on-Reservation work for this project and a past QIN project. This is not a comprehensive plant species list for the Reservation, but is a list of species observed and/or collected during various field visits.

3.5 Hydrology and Climate Change

The western Olympic Peninsula along the coast has an oceanic climate (Koeppen Climate Classification System), which is characterized and controlled by temperature that is somewhat moderated by proximity to a large water body (the Pacific Ocean) and by moisture-laden air moving inland from the ocean, and resulting high volumes of rainfall falling along the western slope of the Olympic Peninsula. Precipitation within the Reservation is high ranging from 100 inches at the western coast up to more than 150 inches at Lake Quinault. Rainfall volumes increase to the east as the clouds pile up along the western side of the Olympics, resulting in annual rainfall totals in excess of 250 inches in the highest elevation areas.

As in most of western Washington, precipitation tends to fall in the winter months, and summer months are comparatively dry. Much of the Reservation is below 1,000 feet elevation, low enough that persistent accumulation of snow is not common. However, the timing of annual hydrology changes in the rivers is greatly affected by snow accumulation and subsequent melt in higher elevation mountains to the east, where snow collects throughout the winter, then melts slowly in the spring, extending periods of higher flows in rivers downstream. As climate change progresses, monitoring climate and maintaining daily weather records will become increasingly important, helping the QIN to track local changes that will not necessarily be the focus of national weather station data collection and data storage efforts.

There are only two currently functional and representative national weather stations near the Reservation that record and store online records of both precipitation and air temperature. Information about these weather stations is provided in the Appendices. Data from these stations may be used to assess and document long-term climate patterns in the vicinity of the Reservation.

As climate change impacts progress, the duration and depth of snow accumulation in the Olympics will decrease, and the runoff events will be more immediate in relation to winter storms. This is likely to result in increased periods of flooding and overbank flows during winter months, and lower late summer flow volumes in the larger rivers, which depend on snow melt for later season runoff. Maintaining long-term climate records will greatly improve planning response and informed decision-making for the QIN.

Hydrology within the Reservation is driven by a combination of extremely high annual rainfall volumes, the timing of precipitation, and the timing of snow melt in the Olympics. As discussed previously, the Reservation typically receives 100 to 150 inches of annual rainfall, with the lower end of the range at the coast, and the upper end of the range at Lake Quinault about 20 miles to the east. 80% of the annual precipitation falls from October through March. By midsummer, rain is infrequent, with lowest average monthly rainfall totals in July. As rainfall increases during fall and early winter months, the relatively shallow soils become increasingly saturated, and wetlands are typically fully hydrated only about two months into the rainy season, starting in December.

Evidence of climate change is increasingly obvious within the Reservation and throughout the Olympic Peninsula and Olympic Mountains to the east. Sea level rise is resulting is more rapid erosion along the coast bluff bases and rocky headlands (Figure 9, 11); increased runoff and winter storms are increasing erosion in rivers and streams; Anderson Glacier, the headwaters of the Quinault River, has been gone since 2011. (Figure 10).

Figure 9. Elephant Rock at the Raft River estuary before and after its collapse in late 2016

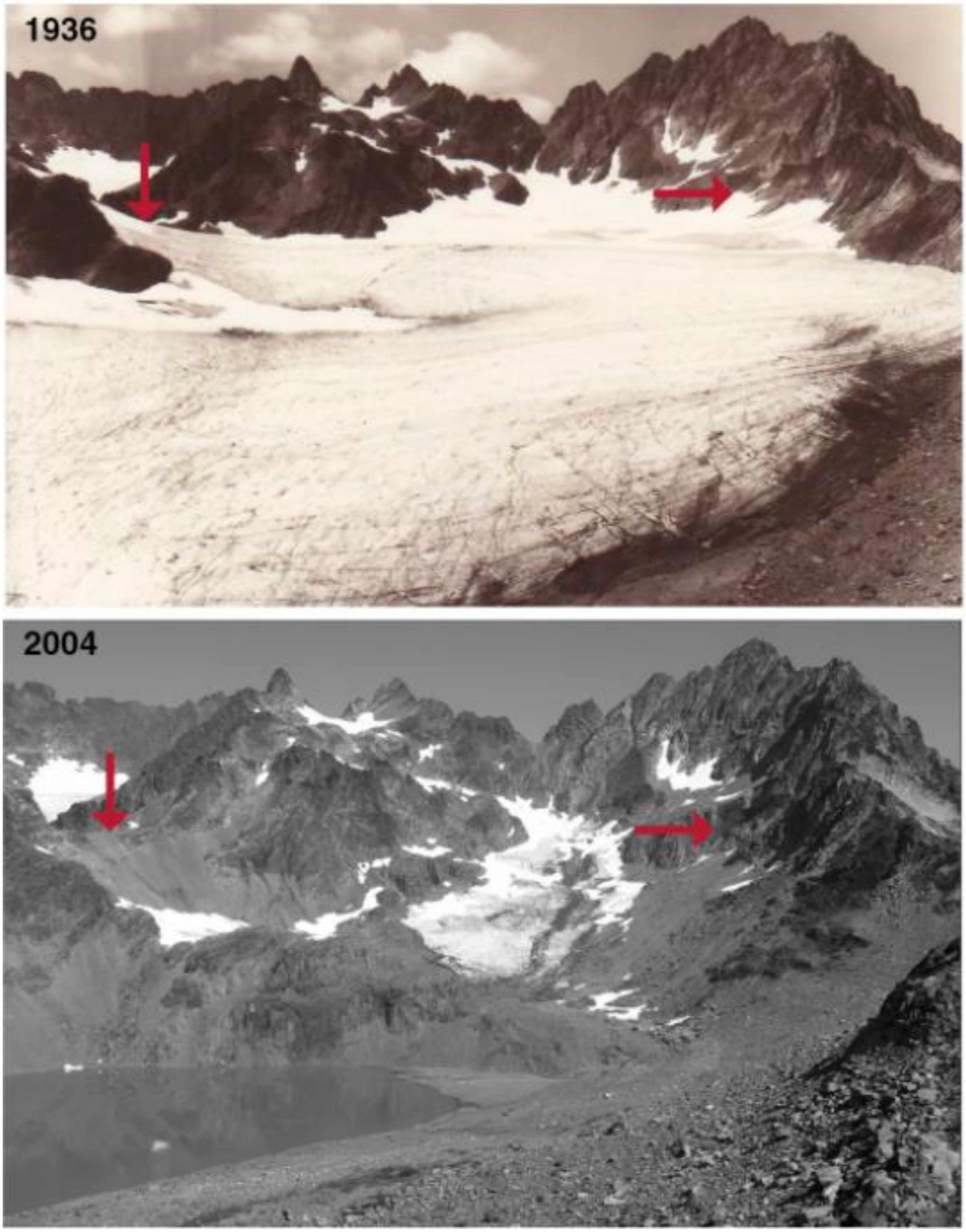

Figure 10. Retreat of Anderson Glacier in the Olympics, headwater to the Quinault River. The glacier has entirely melted, gone since 2011.

Figure 11. Increased erosion at bluff toeslope south of Queets

3.5.1 Climate Change Challenges

A comprehensive description of expected climate change impacts and vulnerabilities for the Olympic Peninsula Region is provided in *Climate Change Vulnerability Assessment for the Treaty of Olympia Tribes: A report to the Quinault Indian Nation, Hoh Tribe, and Quileute Tribe*, February 2016[13]. Expected climate change impacts are summarized below.

Higher Temperature

The average annual temperature in the Puget Sound region (currently 44 degrees F) is projected to warm 5 to 10 degrees during the 21st century, and is expected to be at least 4.2 degrees higher on average by 2050. That means even higher maximum temperatures and ranges. The Reservation may not experience the same level of temperature change as the Puget Sound Region due to ameliorating effects of the Pacific Ocean, which generally reduces extremes by absorbing heat energy. However, the interior of the Reservation is still expected to experience temperature ranges high enough to stress certain plants and animals, as well as humans. The incidence and potential for wildfire in late summer months will increase. The number of animal and plant species is expected to decrease initially, as certain niches that are

[13] https://quileutenation.org/wp-content/uploads/2017/02/Climate_Change_Vulnerablity_Assessment_for_the_Treaty_of_Olympia_Tribes.pdf

dependent on lower temperatures will disappear. New niches will open possibilities for new animals and plants to move in, but with the potential for displacement of existing native species.

More Variable Precipitation

Similar to the increase in temperature, more variable rainfall will disrupt the stability of certain plant and animal life cycles. Extended periods of drought may change species distribution in all Reservation vegetation communities. Prairie species variability, in particular, may decrease due to increased late summer drought, because most of these species are actually wetland plants, and thus are not generally drought tolerant. Other plants or animals that are less tolerant of wide variations in water depth may diminish in number or extent. Increased flooding will have significant impacts on low-lying areas, such as Taholah, and on floodplain infrastructure. Coastal flooding during winter will increase as higher downstream flows combine with effects of high tides to exacerbate already high water surface elevations. These higher periodic rainfall events are also expected to increase the potential for mass wasting – landslides – from oversaturated surface sediments.

Heavier Rainfall during wet periods, combined with minimized snow storage at high elevations in the Olympics will result in extreme flood events during winter months, and lower late summer flows, critical for habitat in salmon-bearing rivers and streams. These extreme floods have the potential to wash out critical roads and culverts, potentially isolating portions of the Reservation from direct road access. This effect will also result in more landslides and erosion, and the associated potential for increased in sediment in river systems.

Sea Level Rise along the coast is not expected to be as extreme as within the Puget Sound. This is partly due to some surfaces along the coast rising in elevation at the same rate as the projected ocean surface elevation. Specifically, the northern tip of the Olympic Peninsula as well as areas near the mouth of the Columbia River are rising.

Still, any sea level rise will increase the extent and frequency of coastal flooding impacts in developed low-lying areas, such as in Taholah and in areas around Moclips, or to State Route 109 near the Wreck Creek Bridge.

Combined effects on salmon may be significant. Warmer rivers and streams will reduce habitat quality. Ocean acidification will reduce food resources. Lower summer flows will reduce habitat and will increase water temperature. Timing of salmon runs may change enough that synchronicity of biologic factors critical to spawning success – such as timing of certain insect hatches or growth of algae – may be altered. These impacts can be offset by planning to maintain tall, persistent vegetative cover along stream and river corridors as well as encouraging and protecting deeper, cooler water habitats (development of pools and scoured side channels).

One interesting expected result of these changes is an increase in coverage by estuaries at river mouths along the coast. However, this same effect is expected to increase coastal erosion from waves and tidal surges, and thus results in recession of bluffs and erosion of beaches.

3.5.2 Assessment of Vulnerabilities

Currently vulnerable infrastructure will become increasingly vulnerable in response to Climate Change. The first step in planning a response is developing an inventory of buildings, roads, culverts, bridges, water and sewer treatment systems, (etc.), and then ranking them as to vulnerability and cost of corrective action. The 2016 QIN Tribal Hazards Mitigation Plan Update[14] provides detailed information about assessments of current vulnerabilities in relation to climate change, earthquakes, tsunami, landslides, wildfire and drought, as well as provides information about mitigation planning.

In addition to this information, other tools are increasingly available that can supplement ongoing vulnerability assessments and planning. The United States Geological Survey (USGS) has developed a Coastal Vulnerability Index in relation to projected sea level rise and potential impacts to habitats and human-built infrastructure[15].

The index assesses a range of variables – geomorphology, coastal slope, relative sea level change, shoreline erosion/ accretion, tidal range and height. Then combines those variables to create a vulnerability “risk of change” matrix for specific geomorphologic features. For example, rocky, cliffed coasts are ranked as having very low risk, because the bedrock base is resistant to erosion. In contrast, sand beaches and salt marsh are ranked as very high risk due to high potential for inundation and high erosion potential.

Applying the index to focus areas with high risk geomorphologies on the Reservation – such as sandy beaches or salt marsh – identifies high-risk zones which can be targeted with site-specific planning tools.

The USGS system includes other relative risk factor models, including “Probability of high Shoreline retreat” and “Probability of stable Shoreline change” at specific areas that will likely be affected with sea level rise. These models assign a 10% to 33% probability for Shoreline retreat around the Raft River and Point Haynisisoos – indicators that suggest a need to focus habitat and slope stability protection efforts in these culturally important areas.

Another USGS database tool provides historical locations of shorelines from 1869 to 2002 along the Washington Coast (from coastal survey maps). The database indicates that most of the Quinault shoreline north of Point Haynisisoos shows little change or inconsistent changes

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[14] Currently available in draft format: http://www.quinaultindiannation.com/documents/Public%20Review%20comments.pdf .

[15] https://catalog.data.gov/dataset/usgs-map-service-coastal-vulnerability-to-sea-level-rise

between the 1929 and 2002, but in general, the younger shoreline is depicted as being farther **east** relative to older shorelines, which indicates that the shoreline is moving inland over time from erosive loss of marine bluffs and beach in those areas. However, in areas south of Point Haynisisoos, the younger shorelines are farther **west** than the older shorelines, indicating that those beaches are building (aggrading) rather than eroding.

Figure 12 shows a section of the shoreline near Wreck Creek with labels on the lines from various years, showing this pattern. If these patterns are correct, then this database provides good documentation of which Quinault shorelines are retreating (eroding) versus advancing aggrading). The shoreline between Point Haynisisoos and Wreck Creek is modeled as changing at a rate of +1 to +2 meters per year (i.e. aggrading).

These patterns of change can be used by the Quinault to help inform relative vulnerability of certain areas and infrastructure, which will make ranking of projects easier. It may also inform design and intention of certain projects.

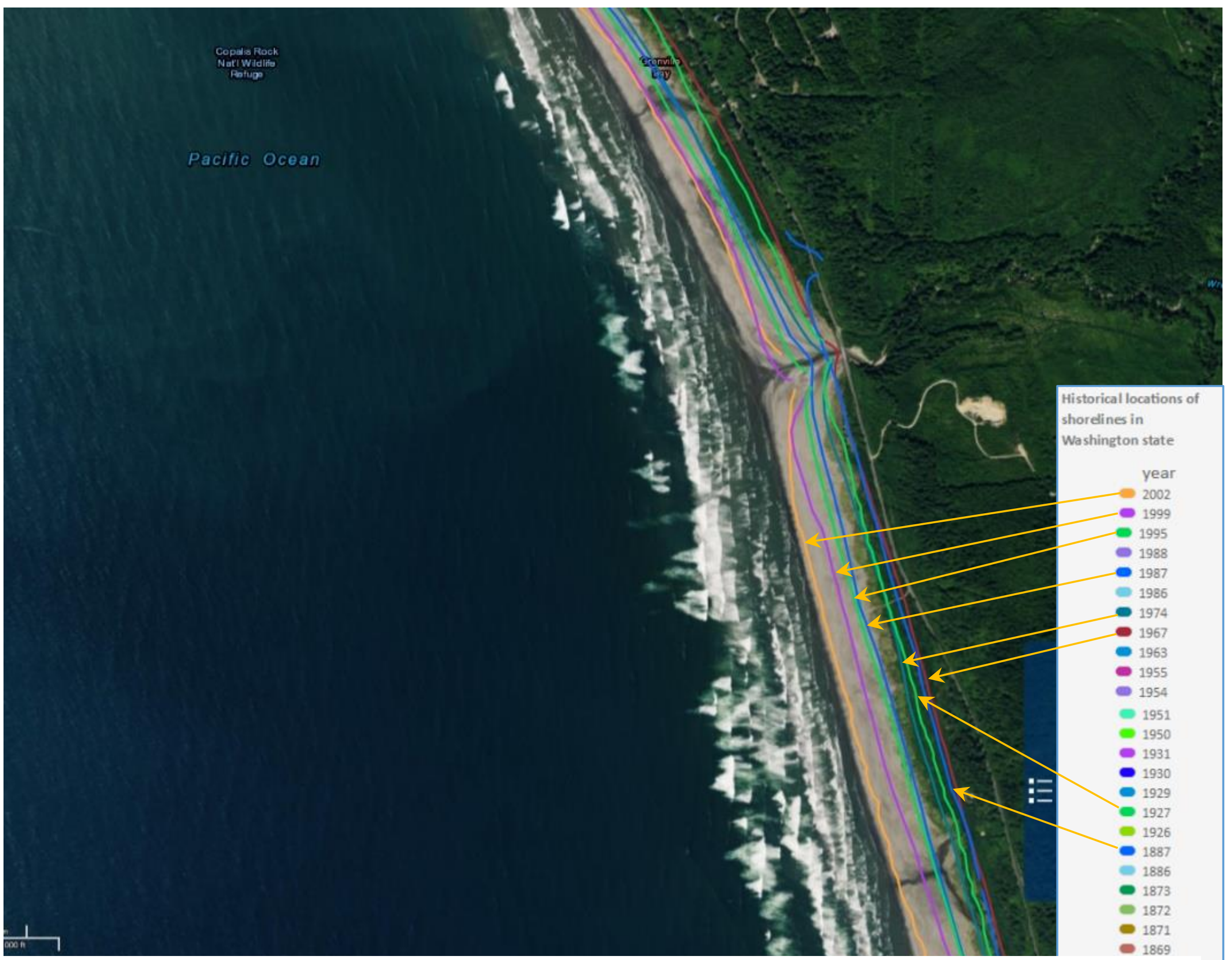


Figure 12. USGS Historic locations of shorelines in Washington state graphic.

3.6 LAND USE AND COVER

The Quinault GIS system has several land use layers – such as forestry, roads, zoning and ownership, which might be analyzed and combined to varying degrees to develop a more detailed single base map with associated polygon attributes.

The predominant Land Use by area (and primary zoning category) on the Reservation is **Forestry** – i.e., managed forests (some of which are managed by non-tribal entities). Most of the lowland Reservation forests have been harvested at least once, some areas two to three times. Some of the clearcuts are in or near the edge of the 100-year floodplain. The mountainous area in the northeast corner of the Reservation appears to still support some older, mature forest stands, but about 60 to 70% of that area appears to have been harvested at some point in the past few decades. Based on patterns indicated on recent aerial photos, about 5% to 10% of the upland forest (outside of riverine floodplains) on the Reservation has been recently cut (within the past 5 years).

Within that predominant Forestry land use are opportunities for Recreation land use – such as hunting or fishing. For **Recreation**, there are at least two protected Audubon Conservation Areas within the Reservation near the coast; some areas in the mountains in the far northeast corner of the Reservation; and Lake Quinault. These protected areas all have site-specific allowed uses, but in general are available for hiking, bird watching and a range of related activities. However, these conservation areas are available only to Tribal members and guests. In addition, QIN Beaches are available only to Tribal members and guests. Some beaches are accessible by motorized vehicles, but on average, access is limited by local geography.

A dense network of managed and unmanaged forest roads is related to the broad coverage by managed forests (**Transportation** land use). These roads, on average, are located about ½ mile apart across most of the Reservation. Some of these roads are no longer maintained and may be in an old clearcut or a no longer accessible floodplain; but they were mapped at some point by the QIN, and thus are potentially available in the future. The roads were built and are used mostly for forestry, but also provide recreation access to rivers and hunting areas as well as access to privately owned parcels within the Reservation.

Residential, **Commercial** and **Industrial** land use areas occur within the Reservation on both Tribal and fee-lands. Outside of commercial forest lands, most of these areas are concentrated along the coast near Taholah, Moclips or Queets, and along the western shore of Lake Quinault in the Amanda Park area.

Residential Land Use includes single family residences in Taholah, Queets and Amanda Park, but also mobile home parks, and some non-tribal residences on fee land north and south of Queets near the beach, and south of Taholah near Point Haynisisoos.

Commercial Land Use includes markets and stores, such as those in Taholah, Queets and Amanda Park, and a motel/ RV park in Amanda Park.

Industrial Land Use includes the Tribally-owned Quinault Pride Seafood facility in Taholah, and three hatchery facilities on the Reservation – one owned and managed by the QIN on the Salmon River, and one co-managed by USFWS on Cook Creek, a tributary to the Quinault River. The QIN also manages fish rearing pens and an associated hatchery/processing plant along the southwestern shore of Lake Quinault. Other industry includes more than 100 gravel pits mapped within the Reservation (most associated with temporary construction of forest roads), and lumber/ wood product industries near Amanda Park.

The primary **Tribal Government** buildings are concentrated in Taholah, but certain other governmental buildings are also located in Queets. There are schools in Taholah, Queets and Amanda Park. A State Highway maintenance facility is in the Amanda Park area, and possibly at other locations within the Reservation. There is a federal Post office in Amanda Park, Taholah, and Queets.

Land Ownership patterns within the Reservation are complex, a checkboard mixture of various Tribal, Trust and Fee ownership categories. Over time, QIN is expanding ownership by purchasing fee lands and converting them into Trust lands. Effective management of Shoreline Areas will be easier if these parcels are regulated under a common system; however, Shoreline Regulations can impose certain limitations, even on fee lands, as site access and related infrastructure is controlled by the QIN. Table 3 can be used to determine which reaches may be prioritized in efforts to convert fee land parcels to QIN Trust status.

Land Ownership Categories

Quinault Indian Nation Owned

- Allotments or other parcels owned 100% by the QIN as to surficial rights. Subsurface rights may or may not be included.
- Can be either in-fee or in-trust status.

Trust

- Any Allotments or parcels where at least one owner, owns any sized interest that is held in trust for the benefit of the Quinault Indian Nation or a federally recognized Indian individual, by the BIA. This applies to either surface or sub-surface rights. Does not include 100% QIN-owned Trust Allotments/Parcels. May contain one or more undivided interest held in fee status. May contain one or more undivided fee or trust interests owned by the QIN.

Fee

- Allotment or other parcels where the surficial rights are 100% owned in fee status by an Indian or most typically a non-Indian individual(s). (Note: it is not readily possible to tell whether an owner is Indian or non-Indian because county assessor's property records do not record this information). Subsurface rights may or may not be included.

Other

- Parcels that do not fall into one of the above categories, essentially a miscellaneous category. A good example would be a county transfer station. No assertions beyond ownership of the land and any buildings thereon, are made.

Table 3. Land Ownership (acres) within the Shoreline Analysis Areas[16]

Reach	Quinault	Trust	Fee	Other	Total Acres	Reach Acres
C1	167.8	190.5	55.6	0	413.9	755.1
C2	287.4	362.1	73.9	0	723.5	745.9
C3	80.9	430.0	372	0	882.9	717.0
C4	164.6	90.0	235.8	0	490.4	534
LQW	46.9	26.1	10.6	0	83.6	83.6
M1	17.9	76.1	0	0	93.9	94
NR	277.3	37.5	47.9	0	362.8	362.8
Q1	154.1	376.9	91.8	0	622.8	622.8
Q2	634.4	1,339.4	218.6	0	2,192.4	2,192.4
QN1	322.8	313.8	22.9	0	659.5	659.5
QN2	1,057.8	4,258.5	142.1	0	5,458.4	5,458.4
QN3	1,647.6	4,692.4	249.8	0	6,589.9	6,589.9
QN4	79.0	131.3	39.4	0	249.6	249.6
R1	81.8	2.6	65.1	0	149.4	149.4
R2	554.1	77.3	879.5	0	1,510.9	1,510.9
S1	164.2	18	0	26.7	209.0	209.0
S2	571.8	583.1	0	0	1,154.9	1,155.0
S3	92.1	0	0	0	92.1	92.1
WC1	4.1	103.8	0	0	107.9	107.5

3.7 Recreation

QIN does not allow non-tribal individuals or groups access to Reservation land and water for recreation unless accompanied by a Tribal member. Therefore, outside of the Amanda Park area, there are no tourism-related recreational opportunities on the Reservation, aside from guided hunting or fishing.

For QIN members, recreational opportunities related to enjoyment of natural areas are endless, partly due to the dense road network described above providing access to even remote areas of

[16] Total acres are not always the same as Reach acres for two reasons: 1. Beach areas outside of parcels do not have an ownership classification; and 2. Some river water areas and road right of ways are not parts of ownership polygons.

the Reservation. Point Haynisisoos is available for individual camping as well as periodic large Tribal gatherings. Beaches and riverine shorelines are accessible from many locations, and many can be accessed on foot or by vehicle. Hunting and fishing are common and available to all QIN members. Gathering of shellfish or kelp along the beaches is allowed, as is gathering of various native plants for cultural purposes.

4. LOCAL SHORELINE CHARACTERIZATION

4.1 Reach Definitions and Boundaries

The purpose of Chapter 4 is to describe existing conditions in the Shoreline Analysis Areas within each Reach. As previously discussed in Chapter 2, for the purposes of assessment and characterization, the Quinault Coastal and Riverine Shorelines were split up into shorter reaches with similar characteristics or management conditions. Table 4 below was provided previously as Table 3, but is provided again for context. Key characteristics of the individual reaches are described below. These descriptions will be used to determine optimal designations for the reaches or subareas within each Coastal or Riverine Reach when writing the Shoreline Management Plan guidance.

Table 4. Baseline GIS Data Layers Analyzed for This Study (This is a copy of Table 3, provided for context to assist with discussion below)

Water Body	Reach (Map Designation)	Location	Length[17] (miles)
Pacific Ocean	C1	Southern Reservation Boundary to Point Haynisisoos (Moclips)	7.45
	C2	Point Haynisisoos to Pratt Cliffs (Taholah/Quinault)	8.09
	C3	Pratt Cliffs to Whale Creek (Raft)	7.33
	C4	Whale Creek to Northern Reservation Boundary (Queets)	4.94
Queets River	Q1	Estuary (Mouth to Upper MHHW)	2.34
	Q2	Upper MHHW to Reservation Boundary	6.32
Salmon River	S1	North Reservation Boundary to Hatchery	2.65
	S2	Hatchery to North Reservation Boundary	7.66
	S3	North Reservation Boundary to End of Upper D-River Boundary	1.69
N. Fork Raft	NR	Raft River Confluence to Upper D-River Boundary	3.06
Raft River	R1	Estuary (Mouth to MHHW)	1.19
	R2	MHHW to Upper D-River Boundary	11.90
Quinault River	QN1	Estuary (Mouth to MHHW)	2.57
	QN2	MHHW to Chow-Chow	14.75
	QN3	Chow-Chow to Narrows ¾ Mile Downstream of U.S. Highway 101 Bridge	15.41
	QN4	Narrows ¾-Mile Downstream of U.S. Highway 101 Bridge to Lake Quinault Outflow	1.72

[17] Length refers to centerline for linear waters, coastline for the ocean, and shoreline for Lake Quinault.

Wreck Creek	WC1	State Route 109 Bridge to Upper Boundary	0.69
Moclips River	M1	Southern Reservation Boundary to Upper D-River Boundary	1.04
Lake Quinault	LQN	North Shore (Olympic National Park)	n/c
	LQS	South Shore (Private and National Forest Lands)	n/c
	LQW	West Shore (Amanda Park Area)	2.63

4.2 PACIFIC COAST REACH DESCRIPTIONS

4.2.1 Coast Reach 1 (C1) – South Reservation Boundary north to Point Haynisisoos (7.45 Shoreline Miles) (Wreck Creek Coastal Reach)

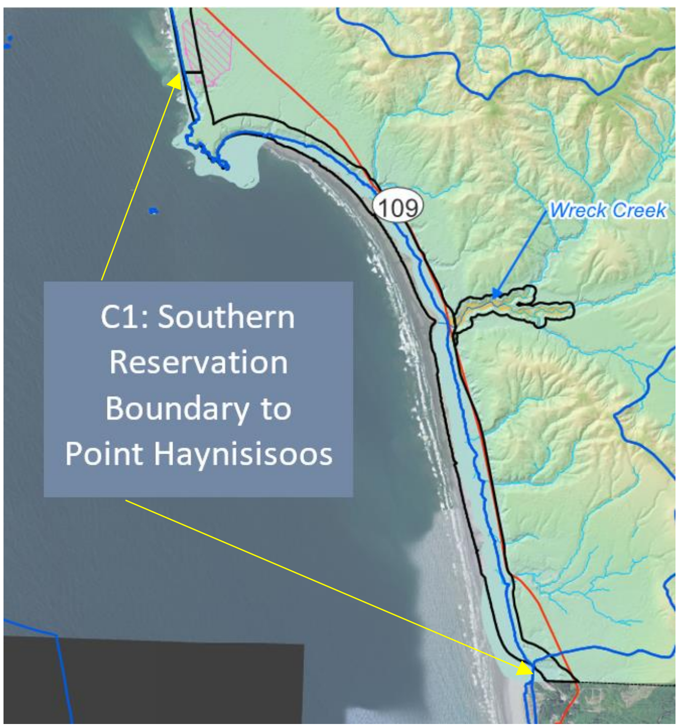


Figure 13. C1 Reach – Includes Wreck Creek and Point Haynisisoos.

Reach C1 starts just north of Moclips at the southern Reservation boundary and extends north to include Point Haynisisoos headlands (7.45 miles) (Figure 13). This Reach includes several significant features that merit monitoring and proactive management. State Route 109 is highly vulnerable due to a low elevation section around the Wreck Creek crossing and due to landslides on higher bluffs near the highway north of Wreck Creek. The lower elevation section is within the 100-year floodplain and even under current conditions can be overrun by king tides. Point Haynisisoos at the north end of this reach is an important and unique geologic formation, being formed primarily of lava rather than the more common sedimentary rocks along the coast, but is also an important cultural resource for the QIN – a place for large gatherings and Tribal events. The islands offshore to the west along the entire coast are part of the Copalis National Wildlife Refuge, and provide critical habitat for important pelagic bird species and marine mammals. The Taholah Ocean Tracts subdivision is accessed from State Route 109 along a section of the roadway that is vulnerable to landslides and tsunami impacts.

Geology Mapping

Common to most of the Reservation, the surficial geology adjacent to the C1 Reach (Figure 14) is mapped mostly as glacial outwash (Qo, permeable, gravelly post-glacial surface flood deposits). However, there are some areas with outcrops of Tertiary age layered siltstones, sandstones and conglomerates (Thsr, Thsu map units). These Tertiary age bedrock units underlay the glacially influenced cap across most of the Reservation and along this reach at some depth. A large sandstone/siltstone outcrop is mapped in uplands south of Wreck Creek (Thsu). The end of Point Haynisisoos is mapped as a basalt lava flow (Tb map unit), the only lava map unit in Reach C1.

Figure 14. Reach C1: 1 to 125K Geology mapping, showing large sandstone, siltstone and conglomerate bedrock area (Thsu) near Wreck Creek; basalt at Point Haynisisoos (Tb); and thin-bedded siltstone bedrock (Thsr) north and south of Point Haynisisoos (Grenville). Uplands are mapped as glacial outwash (Qo).

The bluffs north of Point Haynisisoos are mapped as the Quinault Formation (Tqq map unit), a feldspathic sandstone, which is sometimes fossil-bearing. Please refer to Digital Geology Map A-5 for details.

Soil Survey Mapping

Soil Survey maps only describe the upper 5 to 7 feet of the surface. In this reach, mapping indicates that most of the upland surface on top of the bluffs is glacially influenced, with a relatively impermeable cemented till layer at 3 to 4 feet depth. Seven of the nine soil series listed in Table 5 have substrates of glacial outwash, glacial lake, or glacial drift. These glacial substrates are capped with windblown silts (loess – Calawah soil series), or glacial lake sediments with wetland surface soils (Kydaka, Copalis Rock, Moclips), or surface organic soils (Chow-Chow series). This pattern is consistent with Geology mapping of the surface as glacial materials, and indicates that the underlying bedrock shown in Geology mapping is typically deeper than 5 to 7 feet.

The cemented substrate causes infiltrating stormwater to perch above the restrictive till layer, then drain sideways, usually seeping from the bluff faces near top of slope. This shallow, horizontal drainage of groundwater can cause erosion impacts at the top of the bluff, resulting in landslides and soil sluffing or deep-seated rotational failures in saturated soil areas. This problem is consistent along the entire Coastal Shoreline wherever there are marine bluffs.

The soils mapped along the C1 Reach are only described within the limits of the SAA for this report, but it is recommended to consult the Quinault Soil Survey Map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact hydrologically.

The Soil Map Units in this reach are listed in Table 5. (Please refer to Digital Soil Survey Map A-8 and Quinault Soil Survey for soil map unit details):

Table 5. Reach C1 Soil Map Unit Descriptions

Soil Map Unit	Acres of SMU in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
2-Beaches	343.5	Sand and gravel	sandy gravelly beaches	Tidally influenced	>60"
3-Calawah medial silt loam	6.2	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	Well drained; seasonal high water table >6ft	>60"
7-Chowchow-Water complex	0.98	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till planes	Wetland soil – water to surface most of the year; Very slow runoff; moderately slow over slow permeability	22"-38" to an abrupt textural change

22-**KYDAKA**[18]-Copalis rock complex	74.9	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	Wetland soil – water to surface in during wet months; Permeability is moderately slow above the compact glacial till and very slow within the compact till	25"-45" to dense material
22-Kydaka-**COPALIS ROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	Wetland soil – water to surface most of the year; Very slow runoff; moderately slow over very slow permeability	28"-38" to dense material
23-**KYDAKA**-Moclips complex	1.05	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	Wetland soil – water to surface in during wet months; Permeability is moderately slow above the compact glacial till and very slow within the compact till	25"-45" to cemented layer
23-Kydaka-**MOCLIPS** complex	Same as above	Mucky silt loam	Formed in silty glaciolacustrine deposits over stratified glacial outwash; On glacial outwash terraces	Wetland soil – water to surface in during wet months; Low runoff; moderately slow over very slow permeability	8"-14" and 25"-40" to placic horizon
43-Papac medial silt loam	134.7	Gravelly medial silt loam	Formed in weathered glacial drift; On glacial terraces and till plains	Temporary water table at 1.5-3 ft., (oxyaquic conditions) from Nov-Apr	21"-41" to dense material
61-**WESTPORT** and Dune land soils	144.6	Fine sand	Formed in eolian sand; On dunes	Very rapid permeability	>60"
61-Westport and **DUNE LAND** soils	Same as above	Sand	Formed in eolian sand; On dunes	Excessively drained; seasonal high water table >6ft	>60"

Gravel pits

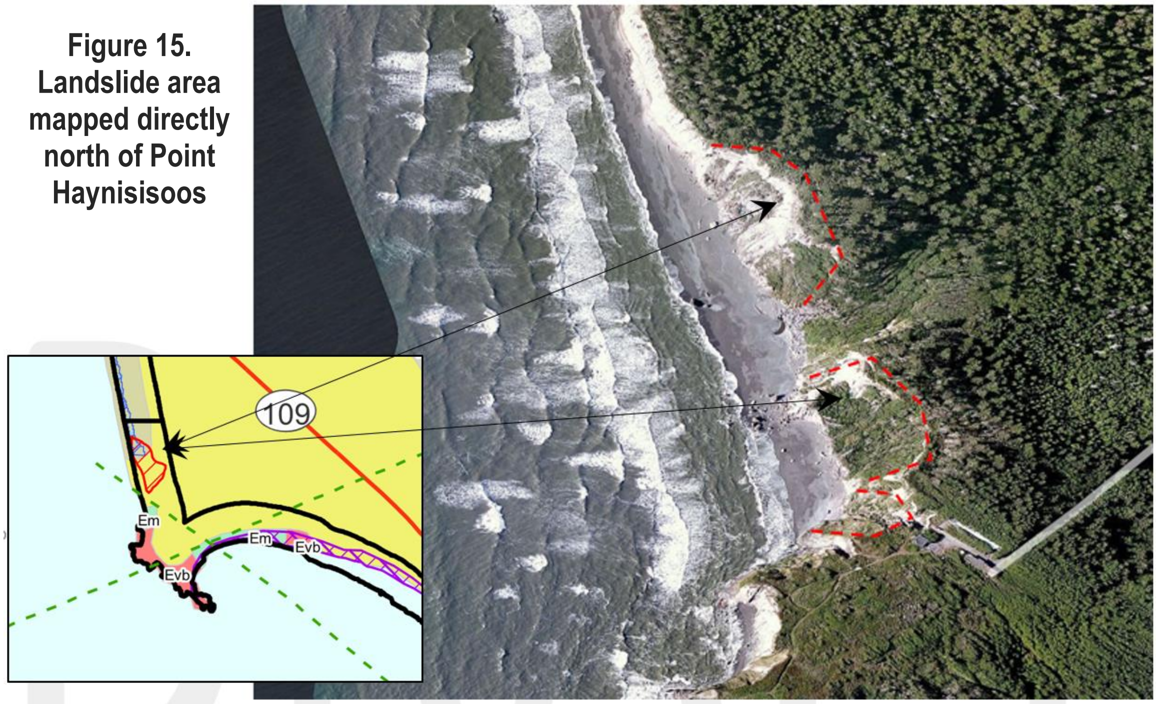
Two small gravel pits are mapped in the vicinity, but both are outside of the SAA. One is just south of Wreck Creek, and one is farther south near Moclips, upslope of State Route 109. Both appear to be associated with logging activities.

[18] When a Soil Complex (i.e., two soil types in one map unit) is described, the **BOLD, CAPITAL** text map unit description is provided in the row to the right, and the other in the row below.

Landslides

Three adjacent landslide areas are mapped in the C1 Reach, directly north of Point Haynisisoos (Figure 15). These landslides, particularly the one farthest south, have potential to impact activities at Point Haynisisoos if the failures continue to expand inland. Upland activities that exacerbate erosion and slope stability should be identified and managed to reduce impacts.

Figure 15. Landslide area mapped directly north of Point Haynisisoos



Tsunami

WaDNR 2010 and 2015 tsunami models indicate that a wave would be expected to wash over the top of bluff and some of State Route 109 along the Reach south of Point Haynisisoos. From Point Haynisisoos north, the bluffs are higher, and the model does not show overtopping.

Critical Features

- Point Haynisisoos, an important cultural resource, gathering place for Quinault events
- State Route 109, the primary connection between Taholah and points south, is vulnerable to winter storms and landslides

Critical Habitats and Species[19]

- Sand lance spawning at the end of Point Haynisisoos
- Rocky shores, beaches, cliffs

[19] Priority Habitats and Species Maps available in Quinault GIS system

- Marbled murrelets are mapped in lower reaches of Wreck Creek, potentially within C1
- Bald eagle nest near the highway about 1.5 miles south of Point Haynisisoos, and north of Point Haynisisoos at the transition to Coast Reach C2.
- Islands offshore to the west are documented as habitat for various pelagic sea birds, and for Peregrine falcons and Harbor seals

Shoreline Access

- Beach access is not allowed by non-tribal members, unless they are accompanied by a Tribal representative.
- Direct and easy access to the beach south of Point Haynisisoos by car from the highway
- Evidence of direct access to the beach from some of the single-family homes north of Wreck Creek
- Direct and easy access to the top of the bluff at Point Haynisisoos by car from the highway

4.2.2 Coast Reach 2 (C2) – Point Haynisisoos to Pratt Cliffs (8.09 Shoreline Miles) (Taholah / Quinault River Reach)

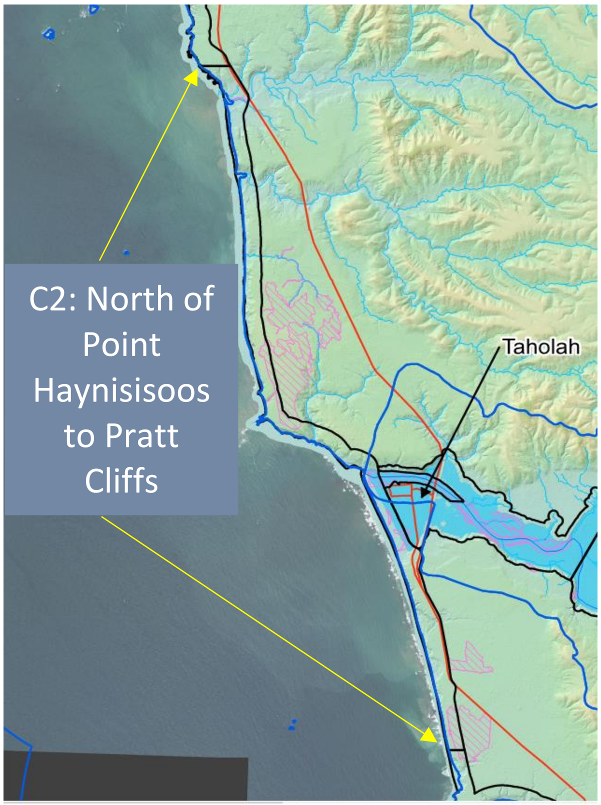


Figure 16. C2, From north of Point Haynisisoos to Pratt Cliffs.

Coast Reach C2 starts just north of Point Haynisisoos and extends north to the south end of Pratt Cliffs (8.09 miles) (Figure 16). This Reach is significant for several reasons. It includes the mouth of the Quinault River – the largest and primary river system in the Reservation, and it includes Taholah – the seat of Tribal Government. It also includes Cape Elizabeth, the highest elevation bluffs on the Reservation, and many miles of relatively inaccessible beach and marine bluff habitat. Duck and Camp Creek, two smaller but important coastal streams drain to the Pacific between Cape Elizabeth and Pratt Cliffs. The islands offshore to the west along the entire coast are part of the Copalis National Wildlife Refuge, and provide critical habitat for important pelagic bird species and marine mammals.

Geology Mapping

Common to most of the Reservation, the surficial geology across most of the uplands adjacent to the C2 Reach (Figure 17) is mapped as glacial outwash (Qo, permeable and gravelly flood deposits). However, in this reach along the coastal bluffs, there are extensive Quinault Formation (Tqq map units) outcrops, a feldspathic sandstone, which is sometimes fossil-bearing. There are only small outcrops of Tertiary age layered siltstones, sandstones and conglomerates (Thts and Thsr map units). A large Tertiary age siltstone outcrop (Thsr map unit) is mapped along the bluff north of the River at Taholah. These geologic map units indicate that bedrock underlies most of the Reservation, below the surficial glacial deposits. Please refer to Digital Geology Map A-5 for details.

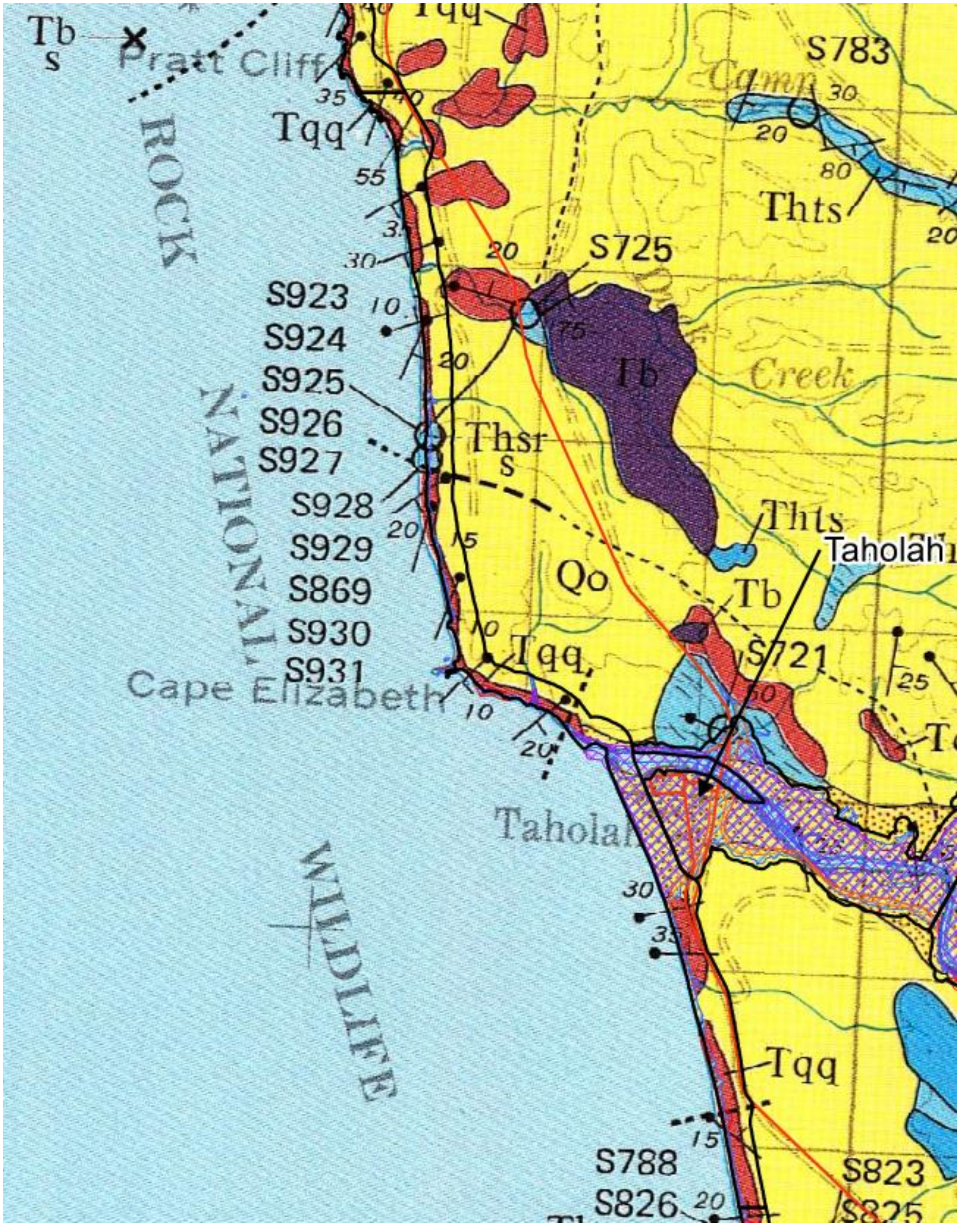


Figure 17. Reach C2: 1 to 125K Geology mapping, showing dominance along the coast of Quinault Formation (Tqq, red), feldpathic sandstone, but also large siltstone bedrock area (Thsr, lt. blue) north of the Quinault River Creek; and several small outcrops mapped as thick-bedded sandstone (Thts, dk. blue). Uplands are mapped as glacial outwash (Qo).

Soil Survey maps

Soil Survey maps only describe the upper 5 to 7 feet of the surface. In this reach, mapping indicates that most of the bluffs are glacially influenced, with a relatively impermeable cemented till layer at 3 to 4 feet depth capped by outwash sediments (Mopang, Matheny Creek, Papac soils), or glacial outwash substrate (Calawah soils). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Hoh, Riverwash soils). Some areas have impermeable substrate with seasonally saturated surface soils (Kydaka, Copalis Rock, Moclips soils).

This mapping is consistent with Geology mapping of the surface, and indicates that the underlying bedrock indicated in Geology mapping is typically deeper than 5 to 7 feet – with one exception – the Palix soils, which are mapped in this SAA have developed from weathered sandstone and siltstone bedrock.

The cemented substrate causes infiltrating stormwater to perch above the restrictive till layer, then drain sideways, usually seeping from the bluff faces near top of slope. This shallow, horizontal drainage of groundwater can cause erosion impacts at the top of the bluff, resulting in landslides and soil sluffing or deep-seated rotational failures in saturated soil areas. This problem is consistent along the entire Coastal Shoreline wherever there are marine bluffs.

The soils mapped along the C2 Reach are only described within the limits of the SAA for this report, but it is recommended to consult the Quinault Soil Survey Map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact hydrologically.

The Soil Map Units in this reach are listed in Table 6. (Please refer to Digital Soil Survey Map A-8 and Quinault Soil Survey for soil map unit details):

Table 6. Reach C2 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
2-Beaches	119.7	Sand and gravel	Sandy gravelly beaches	Tidally influenced	>60", tidally influenced
3-Calawah medial silt loam	4.6	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	Well drained; seasonal high water table >6ft	>60"
5-Chitwhin medial silt loam	58.01	Medial silt loam	Formed in silty alluvium; On low river terraces and floodplains	Subject to rare flooding and frequent ponding	>60", possible surface water
15-Hoh medial fine sandy loam	5.2	Medial silt loam	Formed in mixed alluvium; On low terraces and flood plains	Perched water table at the substratum contact for very brief to brief periods during intense rainfall events	40"-60" to strongly contrasting textural stratification

22-**KYDAKA**-Copalis rock complex	118.6	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	Wetland soil – water to surface in during wet months; Permeability is moderately slow above the compact glacial till and very slow within the compact till	25"-45" to dense material
22-Kydaka-**COPALIS ROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	Wetland soil – water to surface year-round; Very slow runoff; moderately slow over very slow permeability	28"-38" to dense material
23-**KYDAKA**-Moclips complex	99.4	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	Wetland soil – water to surface in during wet months; Permeability is moderately slow above the compact glacial till and very slow within the compact till	25"-45" to cemented layer
23-Kydaka-**MOCLIPS** complex	Same as above	Mucky silt loam	Formed in silty glaciolacustrine deposits over stratified glacial outwash; On glacial outwash terraces	Wetland soil – water to surface in during wet months; Low runoff; moderately slow over very slow permeability	8"-14" and 25"-40" to placic horizon
29-Matheny creek medial silt loam	5.12	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	Moderate permeability above the cemented material and slow through the cemented material	22"-42" to cemented layer
31-Mopang medial silt loam	95.1	Medial silt loam	Formed in glaciofluvial sediments; On outwash terraces on till plains	Moderate permeability to the cemented till and very slow through it; Saturation zone (Nov-Apr) at 4-5 ft.	42"-55" to cemented layer; 50"-65" to dense material
34-**MOPANG**-Calawah complex	136.5	Medial silt loam	Formed in glaciofluvial sediments; On outwash terraces on till plains	Moderate permeability to the cemented till and very slow through it; Saturation zone (Nov-Apr) at 4-5 ft.	42"-55" to cemented layer; 50"-65" to dense material
34-Mopang-**CALAWAH** complex	Same as above	Medial silt loam	Formed in gravelly glacial outwash; On escarpments on outwash terraces	Well drained with no saturation	>60"
41-Palix medial silt loam	25.6	Medial silt loam	Formed in colluvium and residuum from bedrock of siltstone, sandstone and conglomerate lithologies; On hills and mountains	Well drained; slow to rapid runoff; moderate permeability; seasonal water table at 4-5 ft.	42"-62" to paralithic bedrock
42-Papac medial silt loam	11.5	Gravelly medial silt loam	Formed in weathered glacial drift; On glacial terraces and till plains	Temporary water table (oxyaquic conditions) from Nov-Apr	21"-41" to dense material
46-**RIVERWASH**	12.2	Gravelly, sandy	Unstabilized sandy and gravelly deposits that	Floodplain – expected to be seasonally flooded	Surface water

-Water-Udifluvents complex			are reworked by streams and rivers; In river valleys		
46-Riverwash-**WATER**-Udifluvents complex	Same as above	Water	Open bodies of water, such as the Quinault River	Open bodies of water	Surface water

Gravel pits

One small gravel pit is mapped near the SAA, just outside of the SAA, east of the highway, about a mile south of Taholah.

Landslides

Three landslides are mapped in this Reach, two along State Route 109 north of Point Haynisisoos (Figure 18), and one south of Cape Elizabeth, across the River north of Taholah (Figure 19). Other unstable slopes occur in the area and should continue to be monitored.

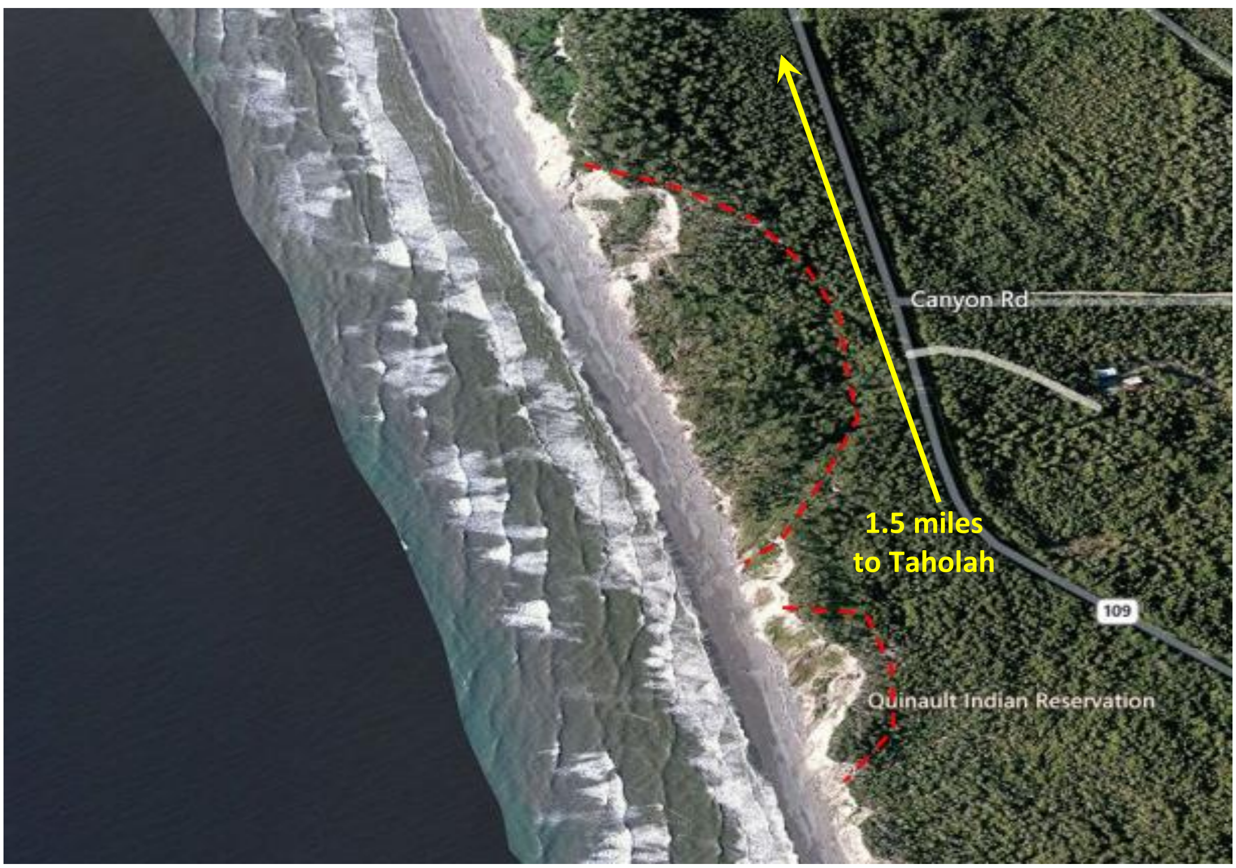


Figure 18. Landslides along State Route 109, north of Point Haynisisoos and 1.5 miles south of Taholah. Red dashed lines indicate the upslope scarp boundary, within 100 feet of the road.

Figure 19. Landslides north of the Quinault River at Taholah, east of Cape Elizabeth.

Tsunami

WaDNR 2010 and 2015 tsunami models provide detailed map information to a point just north of Cape Elizabeth on the Reservation (Figure 20). The models indicate potential for severe inundation across the Quinault mouth with water depths of 20 to 30 feet, covering the current village of Taholah and covering the entire 100-year floodplain upstream about 3 miles. Models show the main channel of the Quinault will be impacted by the surge more than 12 river miles upstream, up to 60+ feet elevation. A tsunami assumed to be at least 30 to 40 feet high would wash about halfway up the marine bluff faces in this Reach. Taholah Village is in planning stages for moving outside of the tsunami hazard zone.

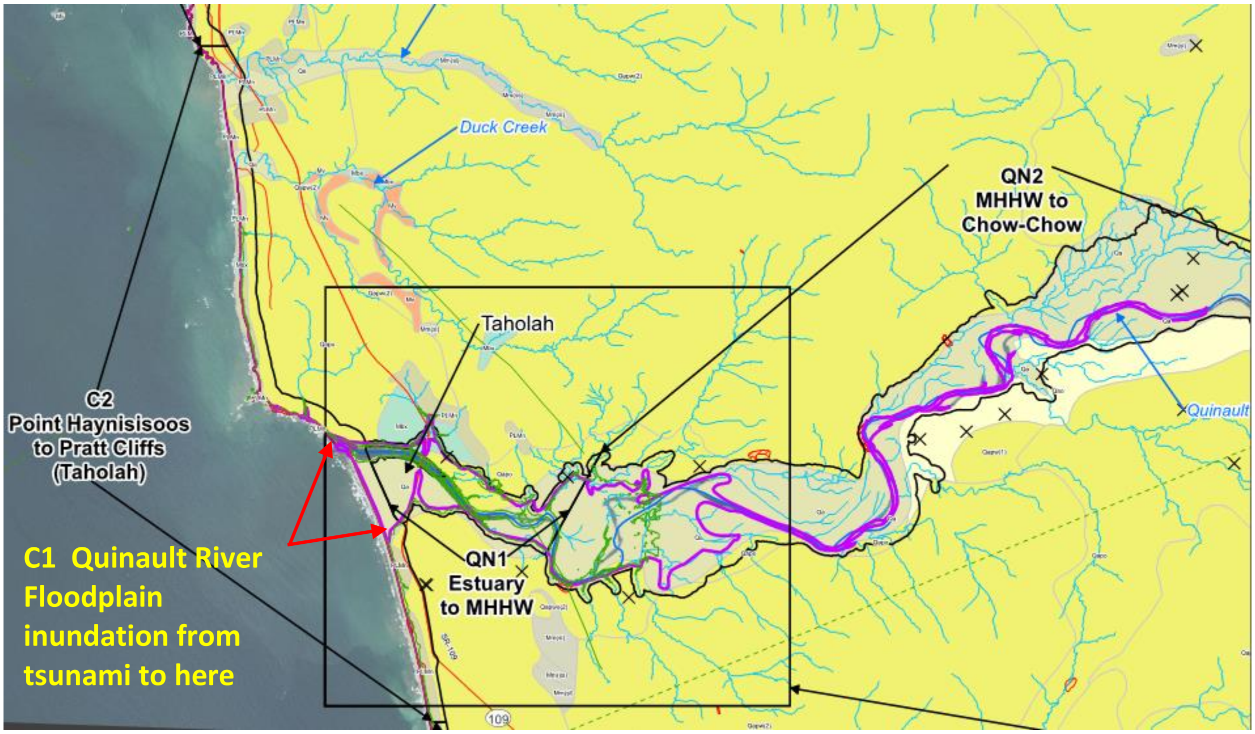


Figure 20. C1 Reach: Tsunami flooding at mouth of Quinault River.

Critical Features

- Taholah, primary urban area on the Reservation, and center of government for the QIN
- Quinault River, largest river on the Reservation, and critically important to commercial fishery
- State Route 109 Bridge across the Quinault River, providing primary access to lands between the Quinault and the Raft River
- Cape Elizabeth, highest elevation bluffs along the Reservation coast

Critical Habitats and Species[20]

- Surf smelt spawning along beach south of Taholah; four spawning reaches between Cape Elizabeth and Pratt Cliffs
- Rocky shores, beaches, cliffs, estuary
- Coho, Resident cutthroat, fall and spring chinook, sockeye (Kokanee), bull trout, steelhead, fall chum, pink salmon are salmonids listed (by WDFW) as being present in the Quinault River
- Bald eagle nest near the highway about ¼ mile north of Point Haynisisoos; two at Cape Elizabeth; one near Camp Creek outlet

[20] Priority Habitats and Species Maps available in Quinault GIS system

- Islands offshore to the west are documented as habitat for various pelagic sea buds, and for Peregrine falcons and Harbor seals

Shoreline Access

- Beach access is not allowed by non-tribal members, unless they are accompanied by a Tribal representative.
- Direct and easy access to the Quinault River and Beach near Taholah from town, possibly via car
- Possible direct access to the Beach from Seagate Road, south of Taholah

4.2.3 Coast Reach 3 (C3) – Pratt Cliffs to Whale Creek (7.33 Shoreline Miles) (Raft River Reach)

This reach starts at Pratt Cliffs and extends north to the north side of the outlet of Whale Creek (7.33 miles) (Figure 21. Significant features within this reach include several unique and culturally important headland features – Hogsback, Little Hogsback, Tunnel Island and Elephant Rock. It also includes the outlet of Whale Creek and North Fork Whale Creek, which flows from Moses Prairie – one of several prairie fens within the Reservation, which provide important cultural resources. The islands offshore to the west up to the Raft River provide critical habitat for important pelagic bird species and marine mammals. There are few if any islands between the Raft River and Ruby Beach, which is about 15 miles to the north, well outside of the Reservation.

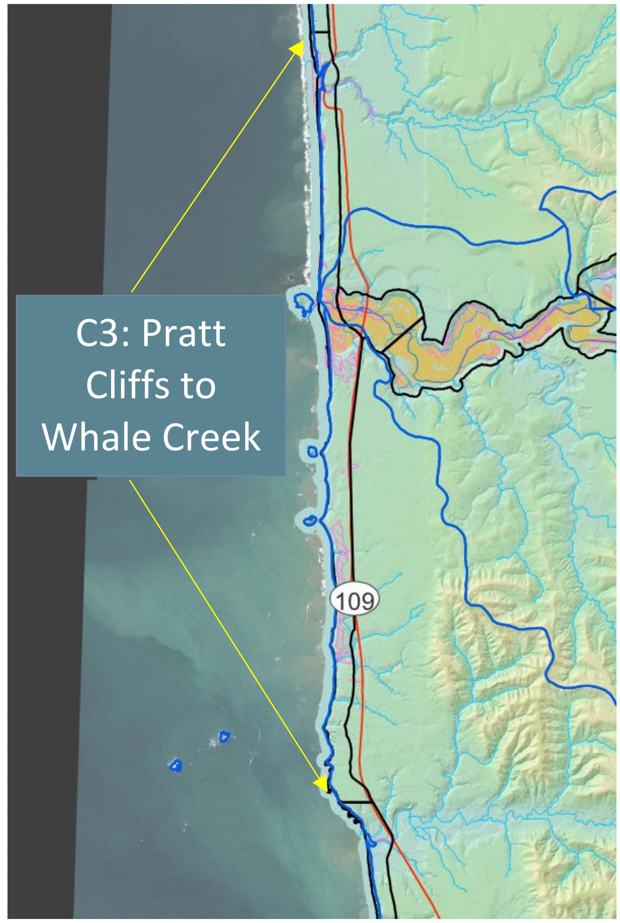


Figure 21. C3, Pratt Cliffs to Whale Creek

Geology Mapping

Common to most of the Reservation, the surficial geology across most of the uplands adjacent to the C3 Reach (Figure 22) is mapped as glacial outwash (Qo), permeable sand and gravel flood deposits). The glacial outwash mapping extends almost to the edge of the marine bluff in most areas, with Tertiary age layered siltstone outcrops (Thsr map unit) forming the steep marine bluff faces. The rock types also form the headlands and islands blocking the Raft River estuary – such as Tunnel Island and Elephant Rock. Pratt Cliffs and headlands just north of the Raft River are mapped as the Quinault Formation, a feldspathic sandstone (Tqq map unit), which is sometimes fossil-bearing. Other eroded headland and offshore islands – such as Hogsback, Little Hogsback and similar features farther south – are mapped as a Tertiary-age basalt (Tb map unit), which is a remnant lava flow. Please refer to Digital Geology Map A-5 for details.

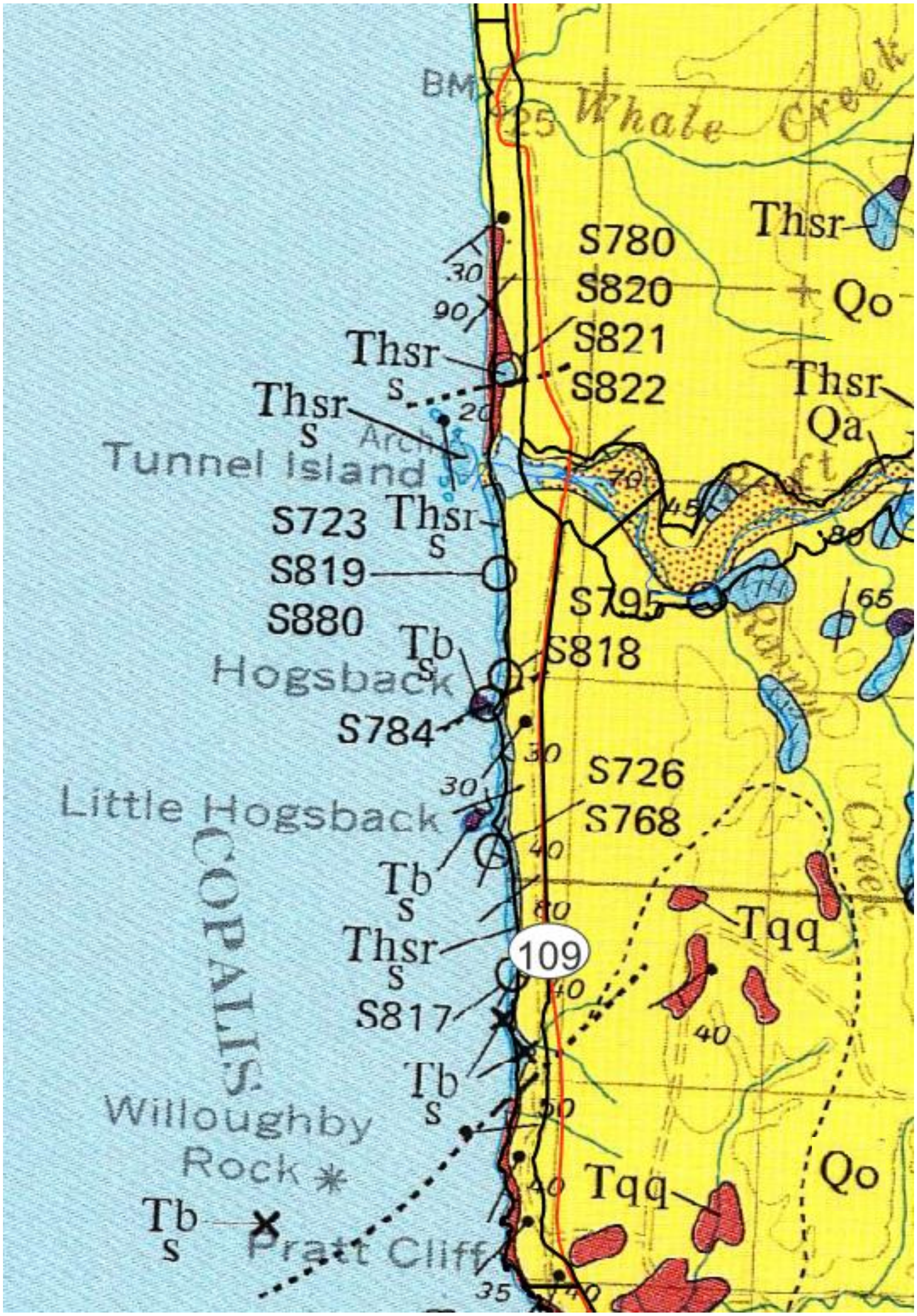


Figure 22. Reach C3: 1 to 125K Geology map, showing occurrence near Pratt Cliffs and north of the Raft River mouth of Quinault Formation (Tqq, red, feldpathic sandstone), but also siltstone bedrock areas (Thsr, lt. blue) at Raft River headlands and islands, and several small outcrops mapped as basalt (Tb). Uplands are glacial outwash (Qo); Rivers are alluvium (Qa).

Soils Mapping

Soil Survey maps only describe the upper 5 to 7 feet of the surface. The soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 3 to 4 feet depth capped by outwash sediments (Mopang, Matheny Creek,), or glacial outwash substrate (Calawah). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Hoh, Riverwash). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock, Moclips, Chow-Chow). Some of the coastal estuary area is mapped as having well-drained sandy sediments (Westport, and Dune Land).

In this reach, like previous reaches, mapping indicates that most of the areas upslope of headlands and marine bluffs are glacially influenced, with alluvium or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. The cemented substrate causes infiltrating stormwater to perch above the restrictive till layer, then drain sideways, usually seeping from the bluff faces near top of slope. This shallow, horizontal drainage of groundwater can cause erosion impacts at the top of the bluff, resulting in landslides and soil sluffing or deep-seated rotational failures in saturated soil areas. This problem is consistent along the entire Coastal Shoreline wherever there are marine bluffs.

The soils mapped along the C3 Reach are only described within the limits of the SAA for this report, but it is recommended to consult the Quinault Soil Survey Map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact hydrologically.

The Soil Map Units in this reach are listed in Table 7. (Please refer to Digital Soil Survey Map A-8 and Quinault Soil Survey for soil map unit details):

Table 7. Reach C3 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
2-Beaches	36.2	Sand and gravel	sandy gravelly beaches	Tidally influenced	>60"
5-Chitwhin medial silt loam	29.8	Chitwhin medial silt loam, forested	Formed in silty alluvium; On low river terraces and floodplains	Subject to rare flooding and frequent ponding	>60"
6-Chowchow peat	3.2	Chowchow peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till planes	Very slow runoff; moderately slow over slow permeability	22"-38" to an abrupt textural change
22-**KYDAKA**-Copalisrock complex	301.7	Kydaka mucky silty clay loam, forested	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	Permeability is moderately slow above the compact glacial till and very slow within the compact till	25"-45" to dense material

22-Kydaka-**COPALIS ROCK** complex	Same as above	Copalisrock peat, forested	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	Very slow runoff; moderately slow over very slow permeability	28"-38" to dense material
23-**KYDAKA**-Moclips complex	103.5	Kydaka mucky silty clay loam, forested	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	Permeability is moderately slow above the compact glacial till and very slow within the compact till	25"-45" to cemented layer
23-Kydaka-**MOCLIPS** complex	Same as above	Moclips mucky silt loam, forested	Formed in silty glaciolacustrine deposits over stratified glacial outwash; On glacial outwash terraces	Low runoff; moderately slow over very slow permeability	8"-14" and 25"-40" to placic horizon
29-Matheny creek medial silt loam	1.3	Matheny creek medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	Moderate permeability above the cemented material and slow through the cemented material	22"-42" to cemented layer
31-Mopang medial silt loam	11.6	Mopang medial silt loam, forested	Formed in glaciofluvial sediments; On outwash terraces on till plains	Moderate permeability to the cemented till and very slow through it; Saturation zone (Nov-Apr)	42"-55" to cemented layer; 50"-65" to dense material
34-**MOPANG**-Calawah complex	148.6	Mopang medial silt loam, forested	Formed in glaciofluvial sediments; On outwash terraces on till plains	Moderate permeability to the cemented till and very slow through it; Saturation zone (Nov-Apr)	42"-55" to cemented layer; 50"-65" to dense material
34-Mopang-**CALAWAH** complex	Same as above	Calawah medial silt loam on a forested	Formed in gravelly glacial outwash; On escarpments on outwash terraces	Well drained with no saturation	>60"
61-**WESTPORT** and Dune land soils	16.2	Westport fine sand, grassland	Formed in eolian sand; On dunes	Very rapid permeability	>60"
61-Westport and **DUNE LAND** soils	Same as above		Formed in eolian sand; On dunes	Excessively drained; seasonal high water table >6ft	>60"

Gravel pits

Four gravel pits are mapped in the vicinity, two inside and two just outside of the SAA. The two within the SAA are mapped on uplands on either side of the Raft River, but these gravel pits are not visible in current aerial photos; thus, must have been quite small originally, and likely were used temporarily. Of the two mapped outside of the SAA, the one south of the Raft is about 1,200 feet east of Cape Elizabeth Road (previously State Route 109); the one north of the Raft is about 800 feet east of the main north-south road north of the River. Both are small, but appear to still be in use.

Landslides

No landslides are mapped within this reach. However, several landslides along the Shoreline between Raft River and Whale Creek are evident from review of aerial photos, and all appear to be associated with impacts from structures near top of slope, possibly from clearing of vegetation near the top of slope or from stormwater runoff from home sites (Figure 23). Steep bluff faces along this reach are constantly eroding from the base, affected by tidal impacts. Loss of the toe of the bluff causes the bluff face above to slide. The rate of toe slope loss is expected to increase with sea level rise, and thus is expected to increase the rate of bluff retreat. This section of the coast should continue to be monitored for evidence of impacts from

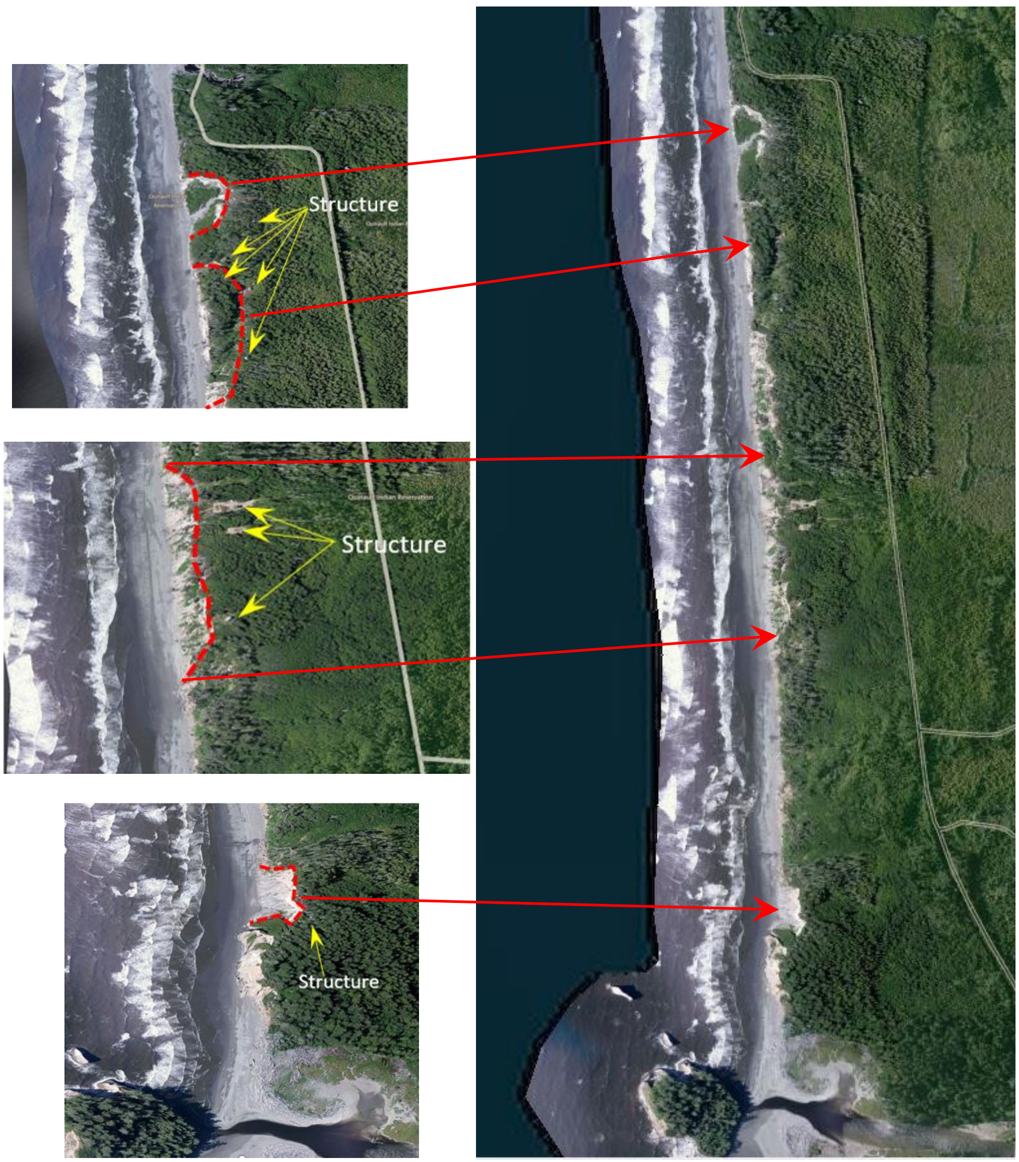


Figure 23. Landslides along Shoreline north of Raft River.

sea level rise. Increased setbacks from top of slope for vegetation removal or infrastructure may be needed.

Tsunami

WaDNR 2010 and 2015 tsunami models do not provide detailed map information north of Cape Elizabeth on the Reservation. However, it is reasonable to assume that impacts from tsunami events would be comparable up the entire coast. This indicates the potential for severe inundation across the Raft River estuary and Whale Creek mouth, with wave impacts to 20 to 30 feet elevation, and main channel surge impacts up to 60+ feet elevation upriver. Tsunami models indicate that a tsunami assumed to be at least 30 to 40 feet high would wash about halfway up the bluff faces. Bluffs along this Reach generally range from 80 to 120 feet elevation.

Critical Features

- Raft River Estuary, relatively pristine estuary, and a culturally significant area
- Headlands and Islands – Tunnel Island, Elephant Rock, Hogsback and Little Hogsback islands
- Whale Creek, outlet near Queets River; downstream from Moses Prairie

Critical Habitats and Species[21]

- Salmon (in the Raft River); surf smelt (3 documented spawning reaches; one south of Raft River, and two south of Whale Creek outlet)
- Estuaries, rocky shores, beaches, cliffs
- Coho, bull trout, steelhead are the salmonids listed (by WDFW) as being present in the Raft River
- Peregrine falcon, on Raft River headlands and at Little Hogshead
- Two bald eagle nests between Pratt Cliffs and Little Hogshead, and at Raft River headlands
- Offshore islands provide nesting, resting and feeding habitat for pelagic birds, harbor seals and Stellar sea lions

Shoreline Access

- Beach access is not allowed by non-tribal members, unless they are accompanied by a Tribal representative.
- Limited access at Raft River Estuary via foot trails; some evidence of access using ATVs
- Evidence of some access from single-family lots at top of bluff

[21] Priority Habitats and Species Maps available in Quinault GIS system

4.2.4 Coast Reach 4 (C4) – Whale Creek to Northern Reservation Boundary (4.94 miles) (Queets River Reach)

This reach starts just north of the outlet of Whale Creek and extends north to the Reservation Boundary (4.94 miles) (Figure 24). Significant features within this reach include the vast and complex Queets River Estuary as well as some relatively dense development on fee land along the Coastal Shoreline, north of the Queets River. As mentioned above, this section of the Quinault Coast does not have offshore islands, but the estuary provides critical habitat for bird species and marine mammals.

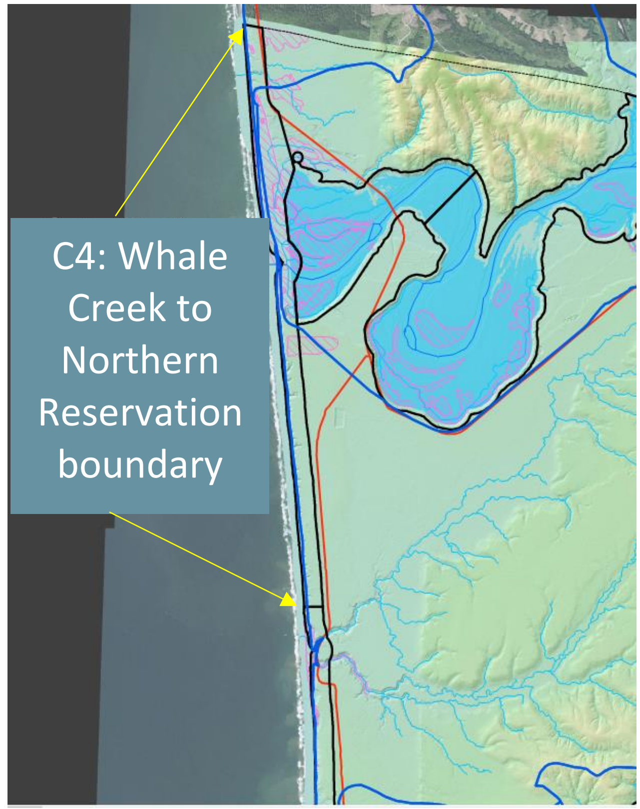


Figure 24. Whale Creek to Northern Reservation boundary.

<u>C4: Coast Reach 4 – Whale Creek to North Reservation (4.94 miles)</u>

<u>Geology Mapping</u>

This section of the Coast has lower relief on average compared to Reach 3 (to the south). The bluffs are not as tall and are more eroded. North of the Queets River, elevation along the top of bluff west of U.S. Highway 101 ranges from 30 to 45 feet. Elevation is even lower in the area northeast of the estuary where the highway turns away from the Coast, ranging from 10 to 30 feet. South of the Queets River, the top of bluff is about 100 feet elevation.

Like most of the Reservation, the surficial geology (Figure 25) across the bluffs and adjacent uplands is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits), but there are no bedrock outcrops mapped along the coast – unlike Reaches farther south. The Queets mouth estuary is mapped as more recent alluvium (Qa). Direct observations of the marine bluff faces during onsite field visits showed that the bluff face is mostly semi-cemented glacial till – not bedrock. This material will be more erosive, and less resistant than bedrock. Reflecting the lack of bedrock map units along the coast bluffs, this section of the coast does not have the offshore headlands or islands, which are common farther south. Please refer to Digital Geology Map A-5 for details.

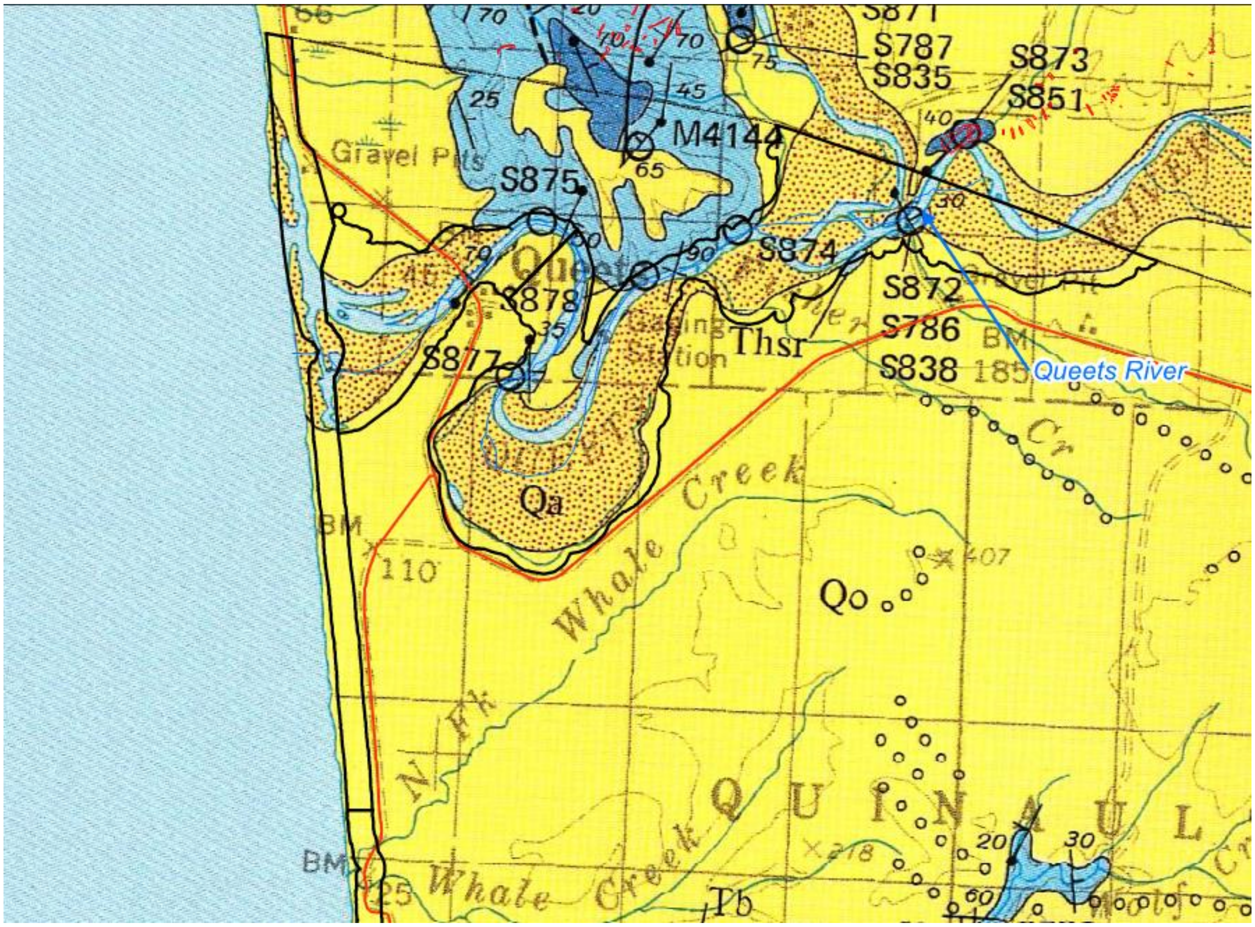


Figure 25. Reach C4: 1 to 125K Geology map, showing no bedrock outcrops at the coast; all uplands and bluffs are mapped as glacial outwash (Qo), and the river is mapped as recent alluvium (Qa). Inland, north of the first bend of the Queets River (outside of C4), there are bedrock outcrops of thin and thick bedded marine sandstones and siltstones (Thsr and Thr).

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface. The soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 3 to 4 feet depth capped by outwash sediments (Mopang, Matheny Creek,), or glacial outwash substrate (Calawah, Solduc). The river floodplain and low terraces are mapped as recent alluvium (Riverwash, Udifluvents). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock, Moclips).

In this reach, mapping indicates that most of the areas upslope of the marine bluffs are glacially influenced, with alluvium or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. But there is no bedrock exposed along the coast in this Reach, unlike the coast farther south. The semi-cemented glacial layers are the whole bluff face, and are more erodible. The impermeable, layered substrates perch seasonal stormwater, causing subsurface water to drain horizontally, surfacing along the bluff faces, forming seeps. Shallow, horizontal drainage of groundwater can cause landslides and soil sluffing from stormwater erosion impacts at the top of the bluff or from deep-seated rotational failures in saturated soil areas where the till cementation is weaker. This problem is consistent along the entire Coastal Shoreline wherever there are marine bluffs, but this area shows evidence of almost constant sluffing and erosion.

In this reach, like previous reaches, mapping indicates that most of the areas upslope of headlands and marine bluffs are glacially influenced, with alluvium or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. Some areas have shallow cemented layers, resulting in perched water as shallow as 8 inches. The cemented substrate causes infiltrating stormwater to perch above the restrictive till layer, then drain sideways, usually seeping from the bluff faces near top of slope. This shallow, horizontal drainage of groundwater can cause erosion impacts at the top of the bluff, resulting in landslides and soil sluffing or deep-seated rotational failures in saturated soil areas. This problem is consistent along the entire Coastal Shoreline wherever there are marine bluffs.

The soils mapped along the C4 Reach are only described within the limits of the SAA for this report, but it is recommended to consult the Quinault Soil Survey Map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact hydrologically.

The Soil Map Units in this reach are listed in Table 8. (Please refer to Digital Soil Survey Map A-8 and Quinault Soil Survey for soil map unit details):

Table 8. Reach C4 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Imp. Substrate or Water
2-Beaches	163.8	Sand and gravel	Sandy gravelly beaches	Tidally influenced	>60"
3-Calawah medial silt loam	2.73	medial silt loam on a forested	Formed in loess over gravelly glacial outwash; On outwash terraces	Well drained; seasonal high water table >6ft	>60"
22-**KYDAKA**-Copalisrock complex	15.1	mucky silty clay loam, forested	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	Permeability is moderately slow above the compact glacial till and very slow within the compact till	25"-45" to dense material
22-Kydaka-**COPALIS ROCK** complex	Same as above	peat, forested	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	Very slow runoff; moderately slow over very slow permeability	28"-38" to dense material

23-**KYDAKA**-Moclips complex	110.3	mucky silty clay loam, forested	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	Permeability is moderately slow above the compact glacial till and very slow within the compact till	25"-45" to cemented layer
23-Kydaka-**MOCLIPS** complex	Same as above	mucky silt loam, forested	Formed in silty glaciolacustrine deposits over stratified glacial outwash; On glacial outwash terraces	Low runoff; moderately slow over very slow permeability	8"-14" and 25"-40" to placic horizon
29-Matheny creek medial silt loam	87.3	medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	Moderate permeability above the cemented material and slow through the cemented material	22"-42" to cemented layer
46-Riverwash-**WATER** complex	41.5	none	Open bodies of water, such as the Quinault River	Surface	water
46-**RIVERWASH**-Water complex	Same as above	gravelly sand	Formed in alluvium; In flood plains	Somewhat poorly drained; Seasonal high water table at 12"-24"	12"-24"
52-Solduc very gravelly medial loam	83.2	very gravelly medial sandy loam, forested	Formed in glacial outwash; On glacial outwash plains or terraces and associated escarpments	Permeability of the subsoil is moderate and permeability of the substratum is rapid	>60"
59-Udifluvents	30.1	gravelly sand	Formed in alluvium; In flood plains	Somewhat poorly drained; Seasonal high water table at 12"-24"	12"-24"

Gravel pits

Four gravel pits are mapped in the vicinity. Three are north of the Queets River. The one mapped west of the highway is no longer visible, but may have been associated with what appears to be a developed Beach access area. Two are mapped east of the highway, and appear to be associated with past logging – perhaps providing materials for building roads. One is mapped south of the River on a high bluff area, and appears to be associated with logging activities.

Landslides

No landslides are mapped within this reach. However, the glacial till bluffs south of the Queets River are actively eroding and slipping, as is clear from recent aerial photos (Figure 26). Some of the erosion appears related to logging activities on top of the bluff, with minimal deep-rooted vegetation remaining at top of slope to hold the soil in place. However, these areas are also being eroded from the beach – possibly evidence of gradually rising sea levels.

The lower elevation bluffs north of the Queets River show no evidence of severe landslide activity. However, there appears to be a scarp face near existing homes along the bluff with a 10 to 15 foot drop to stabilized, vegetated surfaces farther downslope toward the beach. This could indicate washing away of beach sediment, and may reflect an increased rate of bluff retreat toward the existing home sites.

Figure 26. Erosion and slumping in glacial till substrates forming bluffs along shoreline south of the Queets.

Tsunami

The 2010 tsunami model discussed previously does not extend north of Cape Elizabeth. It is reasonable to assume that impacts implied from the 2010 model would be comparable up the entire coast, and in general, tsunami impacts to 25 feet elevation are assumed for areas without modeled impact information. However, a more recent 2015 tsunami model by WaDNR geologists provides predicted tsunami inundation mapping for the Queets area.

Results of the 2015 WaDNR model (displayed on Digital Geology map A-5) show floodplain inundation up to 20 feet elevation, and main channel impacts upstream to 50+ elevation, about a mile past the Clearwater Bridge (Figure 27).

This indicates potential for severe inundation across the Queets River estuary and lower bluffs north of the River, with wave and over-wash impacts of 20 to 30 feet elevation.

Tsunami models indicate that a tsunami assumed to be at least 30 to 40 feet high would wash about halfway up the bluff faces, which range from less than 20 feet up to about 80 feet elevation. A tsunami would almost certainly overtop the single-family home sites and U.S. Highway 101 on the lower bluffs north of the River, but most of the Queets village is not inundated by this modeled event.

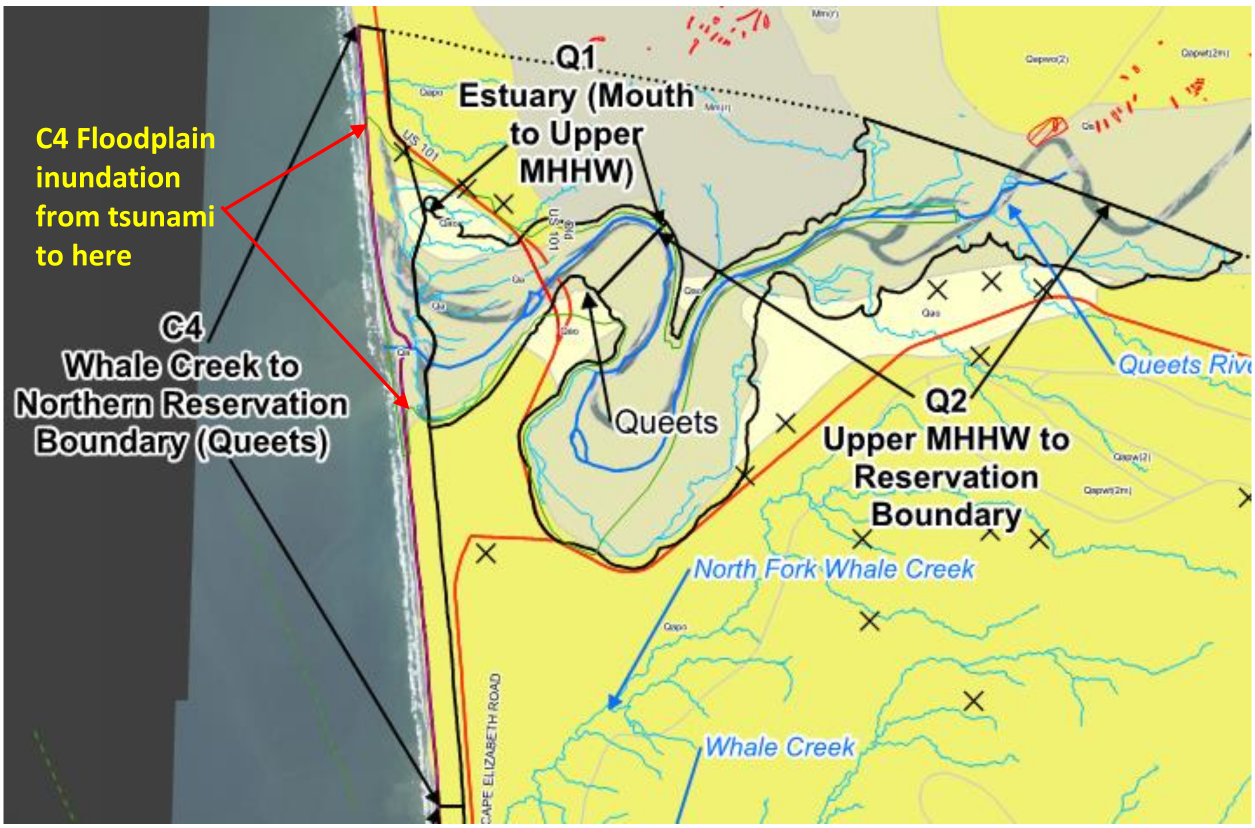


Figure 27. Reach C4: Queets River 2015 tsunami model impacts (green line)

Critical Features

- Queets River Estuary, relatively pristine, critical salmonid habitat, highly variable outlet more than a mile wide
- Privately owned fee lands north of the River susceptible to even smaller (20 to 30 foot waves) tsunami events.
- Eroding bluffs south of the Queets, exacerbated by top of bluff clearing and seeps

Critical Habitats and Species[22]

- Salmon (Queets River); surf smelt (two documented spawning reaches; one directly at the mouth of the Queets River, and one farther south along the beach north of Whale Creek outlet)
- Coho, chinook, steelhead, sockeye, bull trout, pink salmon, cutthroat, fall chum are salmonids listed (by WDFW) as being present in the Queets River
- Estuaries, rocky shores, beaches, cliffs, forested wetlands
- Five bald eagle nests: two on uplands south of the Queets; two in the forested wetlands along the north shore of the River; one along the highway near the north end of the Reservation.

Shoreline Access

- Beach access is not allowed by non-tribal members, unless they are accompanied by a Tribal representative.
- Access for most the Queets estuary is via boat; however, there is a well-defined road/trail along the southern river shoreline that extends almost to the mouth of the Queets River. Vehicles cannot get past a large slough channel in the estuary, but access by foot the rest of the way to the beach is not far and is relatively easy.
- Figure 28 shows developed trail access across the old river channel to the Beach from the fee-owned lot north of the Queets River, described above. Beach access below the MHHW line or OHWM is not allowed by non-tribal members, unless they are accompanied by a Tribal representative.

Figure 28. Showing trail access from fee-owned lot north of the Queets. Beach access is not allowed by non-tribal members, unless they are accompanied by a tribal representative.

[22] Priority Habitats and Species Maps available in Quinault GIS system

4.3 Riverine Reach Descriptions:

4.3.1 Queets River Reach 1 (Q1) and Reach 2 (Q2)

The Queets River is split into two reaches (Figure 29). Q1 is the estuary area, starting at the confluence with the Pacific Ocean, and ending at the MHHW tide elevation upstream (2.34 miles). This is not the same as the tidal influence area, which may extend some distance farther upstream, but represents the zone where salt water mixes with fresh water, and creates unique estuary habitats and management conditions.

Q2 extends upstream from the MHHW elevation to the northern Reservation boundary, which also happens to be near the Clearwater Road Bridge crossing the Queets River and the confluence with the Clearwater River inflow (6.32 miles). This area is described by resident users as being the upstream limit of Tribal commercial fishing. The river farther upstream can still be fished, but it is shallower and more difficult to navigate in a boat, making it less desirable for commercial and even guided fishing.

Q2 includes approximately 2 additional miles of the Queets River above the Clearwater confluence. This section of the River is not large enough to warrant splitting it into a separate Reach Description or management unit, but it is shallower with a wider floodplain.

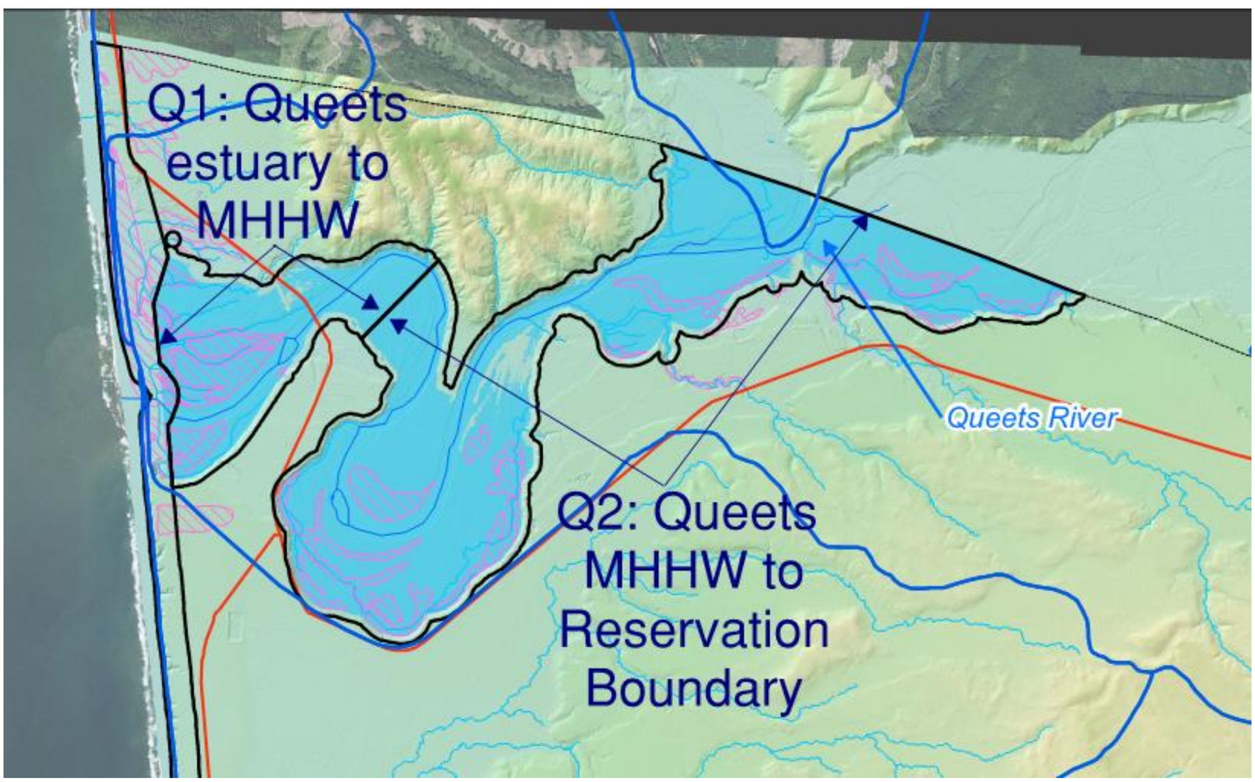


Figure 29. Queets 1 and Queets 2 Reaches.

4.3.2 Queets River Reach 1 (Q1) – Estuary to MHHW elevation (2.34 River Miles)

The mouth of the Queets River at the coast is very active and meanders significantly, with the outlet moving almost a mile from north to south at various times. As a result, the estuary is extensive and contains widely varied vegetation and habitat conditions. This Shoreline Area also includes a small portion of the town of Queets and the U.S. Highway 101 Bridge; forested uplands; freshwater forested wetlands; forested and estuary islands in the River; beach areas extensively covered with large woody debris; lagoon embayments; and remnants of an old farm which may have some historic or cultural value. Elevation at the River surface ranges from 0 feet at the mouth of the River up to about 7.5 feet at the upper end of the Reach (extent of MHHW). The top of the forested terraces between the river bends and within the 100-year flood plain are as high as 35 to 40 feet elevation. The main portion of the town of Queets is above 40 feet elevation, just outside of the 100-year floodplain, but some areas of the town and associated infrastructure are lower and within the floodplain.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits) (Figure 25 – provided in previous Section covers Reaches C4, Q1 and Q2). The Queets mouth estuary is mapped as more recent alluvium (Qa). Direct observations of the bluff faces along the coast during field site visits indicate that the substrate below the outwash surface in this area is semi-cemented glacial till. However, steeper areas ranging from 100 feet to over 400 feet elevation located north of the eastern end of Q1 (at the first river bend) are mapped as Tertiary age layered siltstones, sandstones and conglomerates (Thsl and Thss) – indicating that there are bedrock outcrops of in that area.

The underlying, relatively impermeable glacial till, which appears to dominate across on the terrace surface near the River within the Q1 reach will restrict vertical movement of groundwater, resulting in seepage along river banks and potential for landslides as described in section above. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface. In this reach, like other riverine reaches in the Reservation, mapping indicates that most of the higher terrace surfaces outside of the river channel and floodplain are glacially influenced, with alluvium, loess or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth.

The soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 3 to 4 feet depth capped by outwash sediments (Mopang, Matheny Creek), or glacial outwash substrate (Calawah, Solduc). The river floodplain and low terraces are mapped as recent alluvium (Riverwash, Udifluvents). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock). Soils within the main river channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree, but include some areas of silty alluvium on terraces (Queets). Some of these areas closer to the River are mapped as wetlands, but some slightly higher elevation areas might flood periodically, but are not always wetland

Some of these areas have shallow impermeable or cemented layers, resulting in perched water as shallow as 8 inches, and wetland conditions. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the riverine terrace faces, forming seeps. At river bends, where soils are gradually eroded at toe slope by the river, the effect of horizontal drainage of groundwater and saturated soils at the top of the adjacent terrace is exacerbated, causing sluffing from erosion and larger mass-wasting failures that send huge sediment loads into the river. This problem is consistent along the outside of river bends throughout the Reservation, particularly in the larger rivers with higher winter flows.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 9 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 9. Reach Q1 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
3-Calawah medial silt loam	18.9	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	>72"; No ponding or flooding	>60"
22-**KYDAKA**-Copalisrock complex	12.6	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface; Long, frequent ponding (Jan-Mar and Dec) No flooding	25"-45" to dense material
22-Kydaka-**COPALISROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	At soil surface; Long, frequent ponding (Jan-May and Nov-Dec) No flooding	28"-38" to dense material
29-Mathenycreek medial silt loam	83.5	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	19"-26"; No ponding or flooding	22"-42" to cemented layer

31-Mopang medial silt loam	5.3	Medial silt loam	Formed in gravelly glacial outwash; On outwash terraces	41"-51"; No ponding or flooding	42"-55" to cemented layer; 50"-65" to dense material
34-**MOPANG**-Calawah complex	22.2	Medial silt loam	Formed in glaciofluvial sediments; On outwash terraces on till plains	41"-51"; No ponding or flooding	42"-55" to cemented layer; 50"-65" to dense material
34-Mopang-**CALAWAH** complex	Same as above	Medial silt loam	Formed in gravelly glacial outwash; On escarpments on outwash terraces	>72"; No ponding or flooding	>60"
45-Queets medial silt loam	139.9	Medial silt loam	Formed in silty alluvium; On terraces	>72"; No ponding or flooding	>60"
46-**RIVERWASH**-Water-Udifluvents complex	236.9	sandy and gravelly	Unstabilized sandy and gravelly deposits that are reworked by streams and rivers; In river valleys	No ponding, Very long, frequent flooding (Jan-Jul and Oct-Dec)	Periodic surface flooding
46-Riverwash-**WATER**-Udifluvents complex	Same as above	water	Open bodies of water, such as the Quinault River	Surface water	Surface water
46-Riverwash-Water-**UDIFLUVENTS** complex	Same as above	sandy and gravelly	Formed in alluvium; In flood plains	12"-24"; No ponding, Brief, frequent flooding (Jan-Apr and Nov-Dec)	>60"
52-Solduc very gravelly medial loam	18.7	Very gravelly medial sandy loam	Formed in glacial outwash; On glacial outwash plains or terraces and associated escarpments	>72"; No ponding or flooding	>60"
59-Udifluvents	84.6		Formed in alluvium; In flood plains	12"-24"; No ponding, Brief, frequent flooding (Jan-Apr and Nov-Dec)	>60"

Gravel pits

Two gravel pits are mapped near the northeast edge of the SAA, but none are within the SAA. These were described previously in the C4 Reach Section. They are north of the Queets River, and east of U.S. Highway 101. They appear to be associated with past logging, perhaps providing materials for building roads.

Landslides

No landslides are mapped within this reach. The only apparent potentially unstable areas are associated with periodic movement of the River, creating undercut banks at the outside bends of the River or within the braided channels, which wind through the estuary islands (Figure 30).

It is important to note that the U.S. Highway 101 Bridge was rebuilt at some point in the past due to erosion problems around the foundation of the original bridge, which was located about 500 feet upstream.

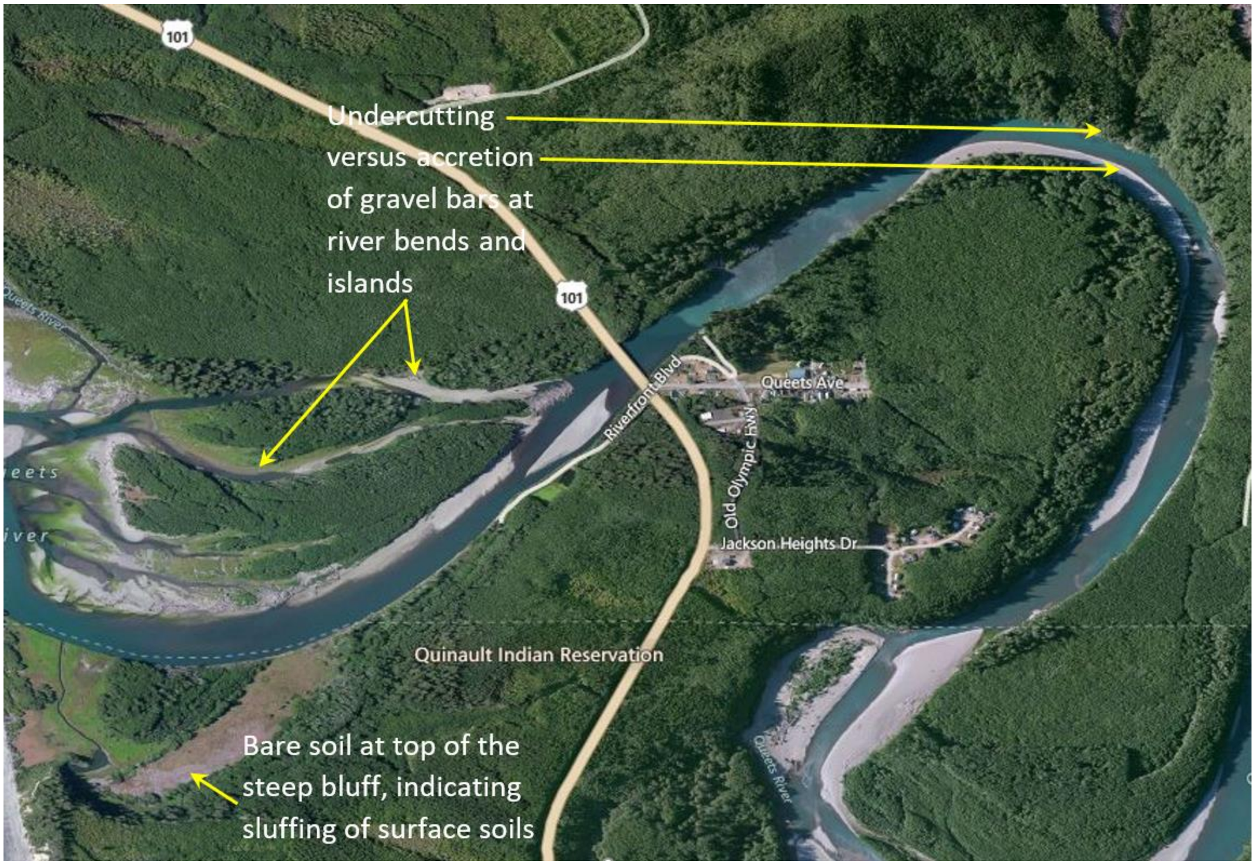


Figure 30. Erosion and slumping in glacial till substrates forming bluffs along shoreline south of the Queets.

The town of Queets is located on a high resistant terrace about 35 to 40 feet above the River surface, with most of the Town just outside of the 100-year floodplain. Riverfront Boulevard initially parallels the southern bank of the River on the higher terrace near town, but it extends west to access the mouth of the River and drops down to run along the edge of the River within the floodplain. This road is the main Beach access, and the river bank below it has been armored to protect from riverbank erosion. The only other potential landslide area within this reach is the steep slope at the edge of the floodplain south of the mouth of the Queets River, which shows bare soil in aerial photos near the top of the bluff face.

Tsunami

The 2010 tsunami model discussed previously does not extend north of Cape Elizabeth. It is reasonable to assume that impacts implied from the 2010 model would be comparable up the entire coast, and in general, tsunami impacts to 25 feet elevation are assumed for areas without modeled impact information. However, a more recent 2015 tsunami model by WaDNR geologists provides predicted tsunami inundation mapping for the Queets area.

Results of the 2015 model (displayed on Digital Geology Map A-5) show floodplain inundation up to 20 feet elevation, and main channel impacts upstream to 50+ elevation, about a mile past the Clearwater Bridge (Figure 31). These wave heights would potentially inundate lower elevation areas near Queets, and could damage or wash out the U.S. Highway 101 Bridge (45 feet elevation) at the Queets River crossing.

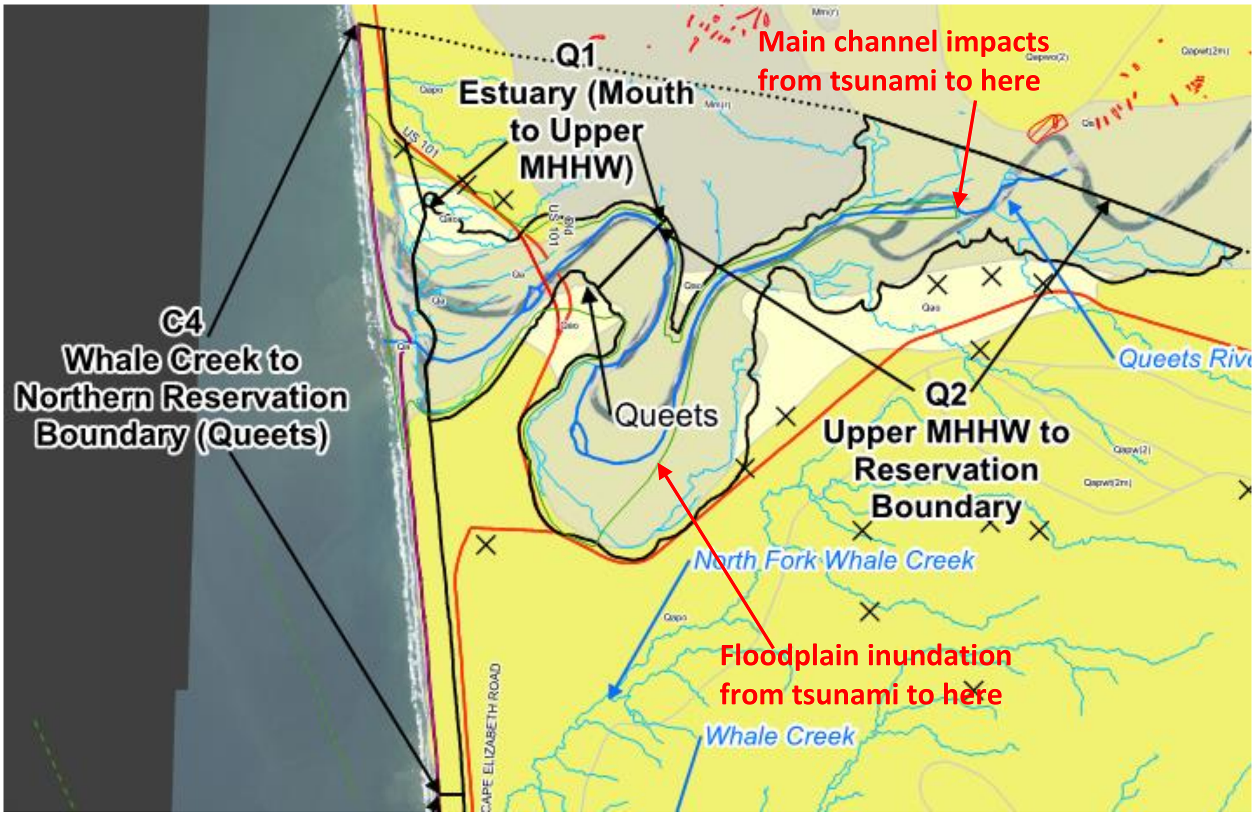


Figure 31. Queets River 2015 tsunami model impacts (green line)

Critical Features

- Queets River Estuary, relatively pristine, critical salmonid habitat, highly variable outlet more than a mile wide
- Riverfront Boulevard, on south shore of River in floodplain
- U.S. Highway 101 Bridge at Queets, providing primary access to points north
- Eroding bluffs south of the Queets estuary, exacerbated by top of bluff clearing and seeps
- Old farmstead on southern terrace, which may contain cultural artifacts
- Queets sewage lagoon on southern bank within the floodplain and susceptible to tsunami impacts

Critical Habitats and Species[23]

- Salmon (Queets River): coho, chinook, steelhead, sockeye, bull trout, pink salmon, cutthroat, fall chum are listed (by WDFW) as being present in the Queets River
- Estuaries, islands; forested and shrub wetlands
- Two bald eagle nests on uplands north of the Queets
- Osprey nest just north of the U.S. Highway 101 Bridge, east of the highway

Shoreline Access

- Access for most of the Queets estuary north of the River is via boat. However, Riverfront Boulevard provides access along the south river bank for about 1,500 feet west of the U.S. Highway 101 Bridge. A poorly maintained dirt road/ foot trail system continues west from that point, and extends to the mouth of the Queets River, providing access to the Beach. Motorized vehicles cannot get past a large slough channel in the estuary near the mouth, although they might be able to drive around on the beach at low tide. Access to the Beach at the River mouth by foot is relatively easy, particularly at low tide. Beach access is not allowed by non-tribal members, unless they are accompanied by a Tribal representative.

4.3.3 Q2: Queets River, Reach 2 –MHHW to Reservation Boundary (6.32 River Miles)

The Queets River in Reach 2 (Q2) meanders significantly (Figure 29, previous Section). It has a wide 100-year floodplain, as much as 6,500 feet across at some locations. The open flow section is about 300 feet across, but adding the many broad gravel and sand bars in the main channel almost doubles that width on average. This Shoreline Area skirts along the east side of the high terrace, which includes the town of Queets, and U.S. Highway 101 runs around the southern edge of the 100-year floodplain at the first river bend. This reach includes forested uplands and freshwater forested wetlands within the 100-year floodplain, and some old logging roads extending into the upper floodplain terrace.

Elevation at the River surface ranges from about 7.5 feet at the downstream end of Q1 up to 40 feet at the confluence with the Clearwater River, and up to 60 feet at the upstream end of the Reach – at the Reservation boundary 1.5 river miles upstream from the Clearwater Bridge. The edge of the floodplain is about 35 to 40 feet in elevation at the downstream end of Q2; about 60 to 70 feet elevation at the confluence with the Clearwater, and about 70 to 80 feet elevation at the far upstream end of the Reach. The top of the upland forested terraces adjacent to the floodplain within the SAA are about 100 to 150 feet elevation. The Clearwater Bridge surface

[23] Priority Habitats and Species Maps available in Quinault GIS system

elevation is at about 80 to 85 feet elevation. The river channel recently moved significantly north in the channel, just upstream of the bridge, and thus, the north bank of the Queets in that area has been armored to protect a section of the Clearwater Road north of the bridge.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands adjacent to the 100-year floodplain is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits). (Figure 25 – provided in previous Section covers C4, Q1 and Q2). Most of the Queets floodplain is mapped as more recent alluvium (Qa). Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till south of the River, but steeper areas north of the River and west of the Clearwater confluence are mapped as Thsl and Thss – indicating that there are bedrock outcrops of Tertiary age layered siltstones, sandstones and conglomerates in that area.

The underlying, relatively impermeable glacial till, which appears to dominate across on the terrace surface near the River within the Q2 reach will restrict vertical movement of groundwater, resulting in seepage along river banks, particularly from the south. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface. In this reach, like other riverine reaches in the Reservation, mapping indicates that most of the higher terrace surfaces outside of the river channel and floodplain are glacially influenced, with alluvium, loess or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. Some of these areas have shallow cemented layers, resulting in perched water as shallow as 8 inches, and wetland conditions. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the riverine terrace faces, forming seeps. At river bends, where soils are gradually eroded at toe slope by the river, the effect of horizontal drainage of groundwater and saturated soils at the top of the adjacent terrace is exacerbated, causing sluffing from erosion and larger mass-wasting failures that send huge sediment loads into the river. This problem is consistent along the outside of river bends throughout the Reservation, particularly in the larger rivers with higher winter flows.

The soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 3 to 4 feet depth capped by outwash sediments (Mopang, Matheny Creek), or glacial outwash substrate (Calawah, Solduc). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Donkey Creek, Hoh, Riverwash, Udifluvents), but the riverine floodplain also includes some areas of silty alluvium on terraces (Queets). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Chow-Chow, Moses Prairie).

In this reach, like other riverine reaches, mapping indicates that most of the terrace areas upslope the 100-year floodplain are glacially influenced, with alluvium or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the terrace faces, forming seeps. Shallow, horizontal drainage of groundwater can cause landslides and soil sluffing from stormwater erosion impacts at the top of the terrace or from deep-seated rotational failures in saturated soil areas where the toe slope has been eaten away by the river.

Soils within the main river channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree. The lower terraces within the floodplain have older alluvium or lakebed sediments as a base, but are capped with more recent alluvium. Some of these areas near and within the River floodplain are mapped as wetlands. Some slightly higher elevation areas might flood periodically, but are not always wetland.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 10 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 10. Reach Q2 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
5-Chitwhin medial silt loam	559.9	Medial silt loam	Formed in silty alluvium; On low river terraces and floodplains	21"-30"; No ponding, Rare flooding (Jan-Mar and Dec)	>60"
6-Chowchow peat	73.1	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Oct-Dec) No flooding	22"-38" to an abrupt textural change
7-Chowchow-Water complex	43.3	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Oct-Dec) No flooding	22"-38" to an abrupt textural change
9-Donkeycreek medial loam	71.4	Medial silt loam	Formed in loamy alluvium over gravelly glacial outwash; On outwash plains	>72"; No ponding or flooding	14"-24" to strongly contrasting textural stratification
15-Hoh medial fine sandy loam	456.0	Medial silt loam	Formed in mixed alluvium; On low terraces and flood plains	>72"; No ponding, Brief occasional flooding (Jan-Mar and Dec)	40"-60" to strongly contrasting

					textural stratification
29-Mathenycreek medial silt loam	63.4	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	19"-26"; No ponding or flooding	22"-42" to cemented layer
34-**MOPANG**-Calawah complex	90.3	Medial silt loam	Formed in glaciofluvial sediments; On outwash terraces on till plains	41"-51"; No ponding or flooding	42"-55" to cemented layer; 50"-65" to dense material
34-Mopang-**CALAWAH** complex	Same as above	Medial silt loam	Formed in gravelly glacial outwash; On escarpments on outwash terraces	>72"; No ponding or flooding	>60"
35-Mosesprairie peat	8.3	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Nov-Dec) No flooding	50"-80" to abrupt textural change
45-Queets medial silt loam	214.2	Medial silt loam	Formed in silty alluvium; On terraces	>72"; No ponding or flooding	>60"
46-**RIVERWASH**-Water-Udifluvents complex	421.6	Sandy, gravelly	Unstabilized sandy and gravelly deposits that are reworked by streams and rivers; In river valleys	No ponding, Very long, frequent flooding (Jan-Jul and Oct-Dec)	Frequent flooding
46-Riverwash-**WATER-** Udifluvents complex	Same as above	Water	Open bodies of water, such as the Quinault River	Surface water	Surface water
46-Riverwash-Water-**UDIFLUVENTS** complex	Same as above	Sandy, gravelly	Formed in alluvium; In flood plains	12"-24"; No ponding, Brief, frequent flooding (Jan-Apr and Nov-Dec)	>60"
52-Solduc very gravelly medial loam	145.1	Very gravelly medial sandy loam	Formed in glacial outwash; On glacial outwash plains or terraces and associated escarpments	>72"; No ponding or flooding	>60"
59-Udifluvents	43.4	Sandy, gravelly	Formed in alluvium; In flood plains	12"-24"; No ponding, Brief, frequent flooding (Jan-Apr and Nov-Dec)	>60"
60-Water	2.4	Open water	Open bodies of water, such as the Quinault Lake	Surface water	Surface water

Gravel pits

Five gravel pits are mapped near the southern edge of the SAA, but only one is close to the SAA. This small gravel pit is located north of U.S. Highway 101 near Moses Creek headwaters, adjacent to a logging road, which extends to a recent clearcut in the floodplain on the east side of the first river bend. The pit appears to be associated with logging, perhaps providing materials for building the road.

Landslides

No landslides are mapped within this reach. However, there are potentially unstable areas are associated with periodic movement of the River, creating undercut banks at the outside bends of the River, as evidenced by recent movement of the Queets River upstream of the Clearwater Bridge, which necessitated armoring the northern bank near the bridge to protect the Clearwater Road, extending north of the River crossing (Figure 32).

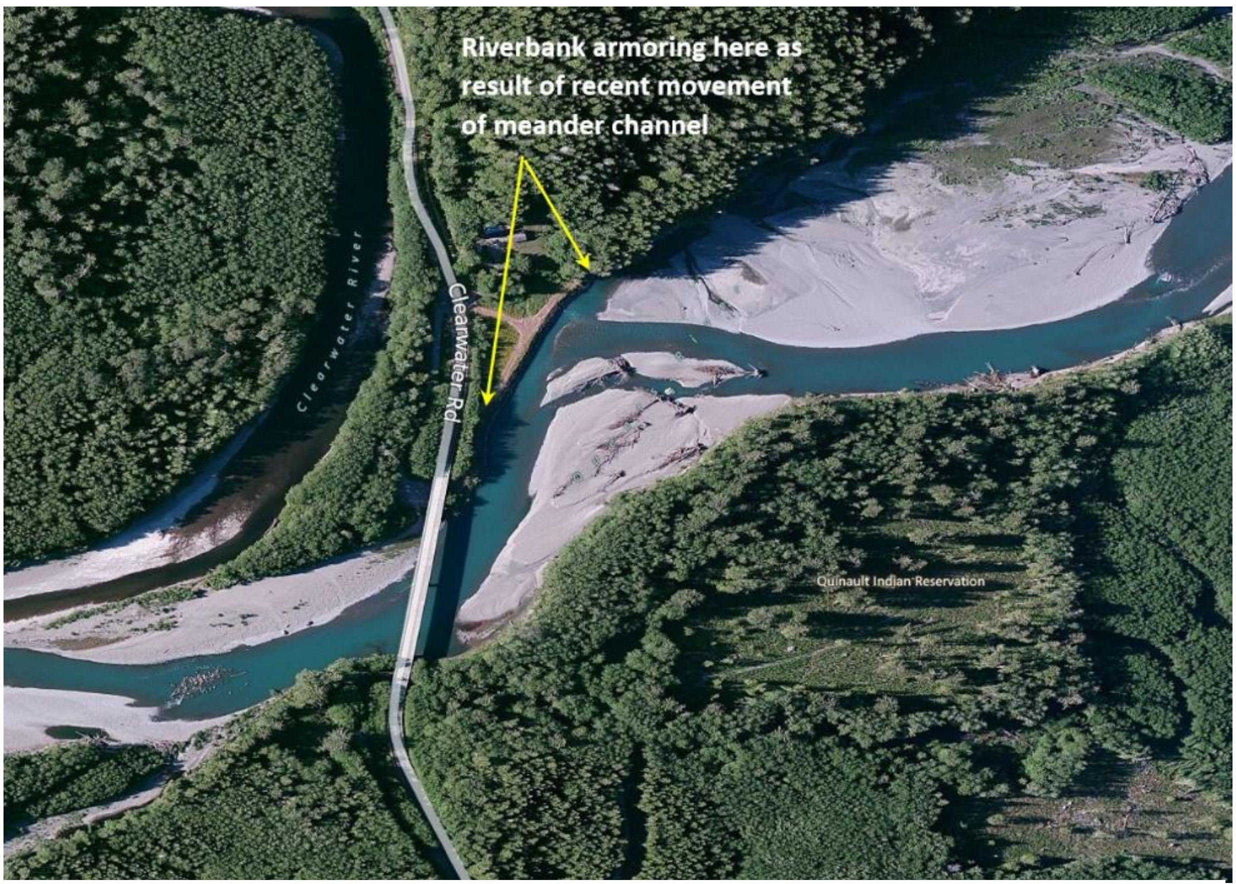


Figure 32. Queets meander channel eroding riverbank near Clearwater Road.

Tsunami

As discussed in the previous section, the 2010 tsunami model does not extend north of Cape Elizabeth. It is reasonable to assume that impacts implied from the 2010 model would be comparable up the entire coast, and in general, tsunami impacts to 25 feet elevation are assumed for areas without modeled impact information. However, a more recent 2015 tsunami model by WaDNR geologists provides predicted tsunami inundation mapping for the Queets area.

Results of the 2015 model show floodplain inundation up to 20 feet elevation, and main channel impacts upstream to 50+ elevation, about a mile past the Clearwater Bridge (Figure 31, previous section). These wave heights could potentially damage or wash out the U.S. Highway 101 Bridge (45 feet high) at Queets, making the Clearwater Bridge (about 89 feet elevation) the only other crossing of the Queets River providing access to points north.

Critical Features

- Queets River floodplain, critical salmonid habitat, highly variable meander channel more than a mile wide at certain sections
- Proximity to Jackson Heights along the west bank.
- Clearwater Bridge, providing secondary access to points north (relative to U.S. Highway 101 Bridge)
- Eroding riverbanks near the Clearwater Bridge, exacerbated by recent river channel meanders
- Forested wetlands in river floodplain

Critical Habitats and Species[24]

- Salmon (Queets River): coho, chinook, steelhead, sockeye, bull trout, pink salmon, cutthroat, fall chum are listed (by WDFW) as being present in the Queets River
- River floodplain, forested and shrub wetlands
- Bald eagle
- Two osprey nests in the floodplain south of the first river bend, north of U.S. Highway 101, and one osprey nest south of the River about ¾ mile downstream of the Clearwater Bridge
- Spotted owl habitat mapped in the Township starting about a mile downstream of the Clearwater Bridge

Shoreline Access

Access for most of the Queets River in Q2 is via boat. However, there are several small logging roads extending into the floodplain which also provide access to varying degrees, based on road conditions and whether there is a gate.

[24] Priority Habitats and Species Maps available in Quinault GIS system

4.3.4 Salmon River Reaches

The Salmon River is an upstream tributary of the Queets River which flows into the Queets about 3.5 miles upstream of the confluence with the Clearwater River, outside of the Reservation. The Salmon River emanates from a mountainous area in the northeast Reservation and meanders along the north Reservation boundary. It is split into three reaches (Figure 33).

Reach S1 starts where the Salmon exits the north Reservation boundary, about ½ mile from its confluence with the Queets River outside of the Reservation. The upstream end of S1 is at the Salmon River Fish Hatchery, a Quinault Tribal Enterprise (2.65 miles).

Reach S2 starts at the hatchery, extending 7.66 miles upstream through forest lands to where the Salmon River again meanders outside of the north Reservation boundary. The floodplain along this Reach is about 1,500 feet wide.

Reach S3 is farther upstream, starting at the north Reservation boundary where the Salmon meanders back into the Reservation, and extending upstream 1.69 miles to the end of the designated D-River. This section of the River is in the mountains. It has a minimal floodplain and steeper terrain.

S1: Salmon River, Reach 1 – North Reservation Boundary upstream to Hatchery (2.65 River Miles)

The downstream portion of Reach 1 (S1) in the Salmon River is a much smaller system than the Queets. It meanders significantly, like the Queets, but is much narrower. Aside from two small sections where the River bends and a side channel enters, the active floodplain, including gravel and sand bars, is only 50 to 80 feet wide, and the 100-year floodplain is about 490 feet wide. The active floodplain in the two wider sections is about 350 feet wide, mostly gravel bar; the 100-year floodplain is more than 1,200 feet wide. The main flow channel is about 40 to 50 feet wide.

The small upstream section, which includes the Salmon River Hatchery (a Quinault Tribal Enterprise) is the beginning of a wider section of the Salmon – with the active floodplain averaging around 350 to 400 feet across, and the 100-year floodplain being over 2,500 feet wide.

Elevation at the River surface ranges from about 120 feet at downstream end of S1 up to about 180 feet at the upstream end, with a slope of less than 0.5%. The edge of the 100-year floodplain ranges from about 140 feet at the downstream end of the Reach up to about 200 feet at the upper end near the Fish Hatchery. The top of the forested terraces and slopes within the SAA on both sides of the River range from between 160 to 300 feet elevation.

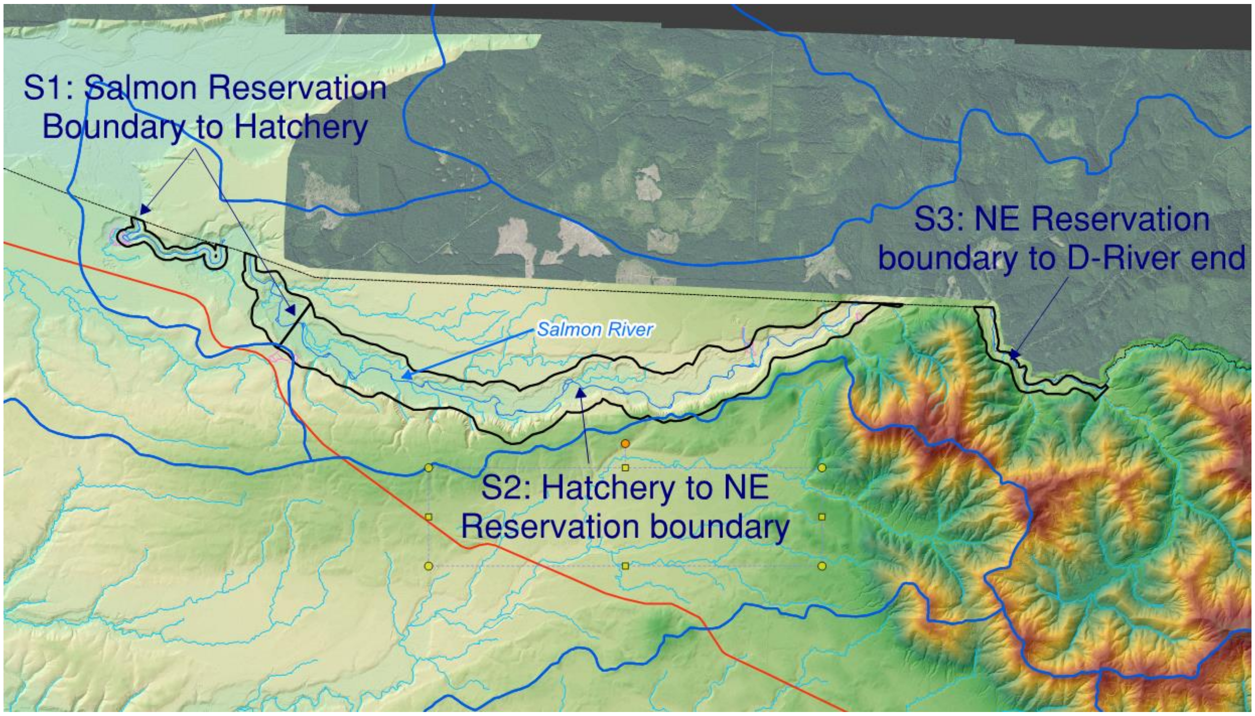


Figure 33. Salmon River Reaches S1, S2, and S3.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands and within the narrow 100-year floodplain at this location is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits), although it can be assumed that the Salmon River floodplain is more recent alluvium (Qa) (Figure 34).

Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till, but there is a small area nearby (at the western end of S2) mapped as being bedrock of undifferentiated Tertiary rocks – sandstone dominant with less than 40% siltstone and argillite, and some fossil-bearing layers (Tur map unit). This resistant bedrock layer mapped nearby might be why the river channel is so narrow in downstream sections of this reach. But the dominant geology on the terrace surface near the River is a glacial outwash plain with underlying, relatively impermeable glacial till. This geology will restrict vertical movement of groundwater, resulting in seepage along river banks. Please refer to Digital Geology Map A-5 for details.

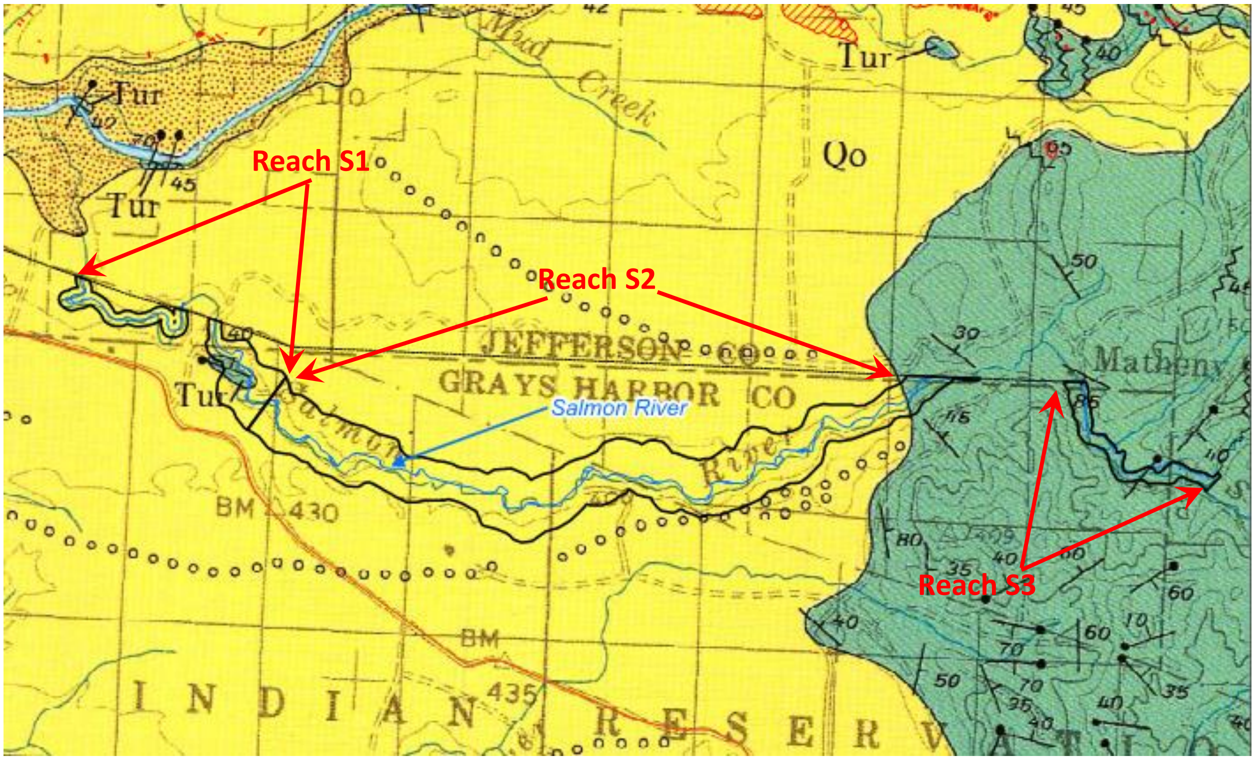


Figure 34. Geology map for S1, S2 and S3.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but the soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 3 to 4 feet depth capped by outwash sediments (, Matheny Creek, Southshore, Stequehato), or glacial outwash substrate (Solduc). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Hoh, Riverwash, Udifluvents), but the riverine floodplain also includes some areas of silty alluvium on terraces (Queets). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock).

In this reach, like other riverine reaches, mapping indicates that most of the terrace areas upslope the 100-year floodplain are glacially influenced, with alluvium or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the terrace faces, forming seeps. Shallow, horizontal drainage of groundwater can cause landslides and soil sluffing from stormwater erosion impacts at the top of the terrace or from deep-seated rotational failures in saturated soil areas where the toe slope has been eaten away by the river. Sluffing from erosion and larger mass-wasting failures that send huge sediment loads into the river. This problem is consistent along the outside of river bends throughout the Reservation, particularly in the larger rivers with higher winter flows.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 11 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 11. Reach S1 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
5-Chitwhin medial silt loam	32.6	Medial silt loam	Formed in silty alluvium; On low river terraces and floodplains	21"-30"	>60"
15-Hoh medial fine sandy loam	16.2	Medial silt loam	Formed in mixed alluvium; On low terraces and flood plains	>72"	40"-60" stratification
22-**KYDAKA**-Copalisrock complex	4.5	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface	25"-45" to dense material
22-Kydaka-**COPALISROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	At soil surface	28"-38" to dense material
29-Mathenycreek medial silt loam	17.3	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	19"-26"	22"-42" to cemented layer
45-Queets medial silt loam	8.5	Medial silt loam	Formed in silty alluvium; On terraces	>72"	>60"
46-**RIVERWASH**-Water-Udifluvents complex	53.5	Sandy, gravelly	Unstabilized sandy and gravelly deposits that are reworked by streams and rivers; In river valleys	Flooding	Flooding
46-Riverwash-**WATER**-Udifluvents complex	Same as above	Surface water	Open bodies of water, such as the Quinault River	Surface water	Surface water
46-Riverwash-Water-**UDIFLUVENTS** complex	Same as above	Sandy, gravelly	Formed in alluvium; In flood plains	12"-24"	>60"

52-Solduc very gravelly medial loam	58.6	Very gravelly medial sandy loam	Formed in glacial outwash; On glacial outwash plains or terraces and associated escarpments	>72"	>60"
56-Southshore gravelly medial silt loam	0.8	Extremely gravelly medial silt loam	Formed in alpine glacial till; On outwash plains	41"-51"	42"-62" to cemented layer
57-Stequateho gravelly medial loam	3.6	Gravelly medial loam	Formed in alluvium over glacial outwash; On outwash terraces	30"-60"	47"-57" to strongly contrasting textural stratification
59-Udifluvents	5.7		Formed in alluvium; In flood plains	12"-24"	>60"

Gravel pits

Three gravel pits are mapped near the southern edge of the SAA, but none are within the SAA. The nearest gravel pit is on uplands 1,500 feet to the south near U.S. Highway 101. The pits appear to be associated with logging or road building/ maintenance activities.

Landslides

No landslides are mapped within this reach. There are potentially unstable areas are associated with undercut banks at the outside bends of the River, but there is no evidence of significant recent erosion in aerial photo records.

Tsunami

No tsunami impacts will occur this far upstream from the Ocean.

Critical Features

- Salmon River floodplain, critical salmonid habitat downstream from a fish hatchery
- Salmon River Fish Hatchery facility – diversion dam, hatchery buildings and rearing pens
- Forested wetlands in river floodplain; Forested uplands on adjacent terraces

Critical Habitats and Species[25]

- Salmon (in Salmon River): coho, chinook, steelhead, bull trout, cutthroat, fall chum are listed (by WDFW) as being present in the Salmon River

[25] Priority Habitats and Species Maps available in Quinault GIS system

- River floodplain, forested and shrub wetlands
- Spotted owl habitat mapped in the Township covering this entire Reach

<u>Shoreline Access</u>

Access for the downstream sections of the Salmon River in S1 would be from small adjacent logging roads or on foot. This section of the River might be navigable by boat, but probably only during periods of high water.

Access to the Shoreline near the Fish Hatchery area would be from the well-maintained gravel roads described above; otherwise, access is by foot.

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S2: Salmon River, Reach 2 – From Hatchery upstream to North Reservation Boundary (7.66 River Miles)

The Salmon River in Reach 2 (S2) has a wider floodplain than most of S1; most of S2 is similar to the area near the Fish Hatchery in S1. It meanders more, and includes more river bends with broad gravel and sand bars. The active floodplain, including gravel and sand bars, ranges between 50 and 500 feet wide; the 100-year floodplain ranges from 2,000 to 3,000 feet wide. At the far upstream eastern end of S2, where the River moves outside of the Reservation for a short section, the Reach narrows as it enters more mountainous terrain.

Elevation at the River surface ranges from about 180 feet at downstream end of S2 up to about 400 feet at the upstream end, with a slope of less than 1%. The edge of floodplain ranges from about 200 feet elevation at the downstream end of the Reach up to about 430 feet at the upstream end. The top of the forested terraces within the SAA on both sides of the River range between about 340 to 520 feet elevation.

<u>Geology Mapping</u>

Like most of the Reservation, the surficial geology across the uplands and within the narrow 100-year floodplain at this location is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits), although it can be assumed that the Salmon River floodplain is more recent alluvium (Qa) (Figure 34, previous section).

Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till, but there is a small area nearby (at the western end of S2) mapped as being bedrock of undifferentiated Tertiary rocks – sandstone dominant with less than 40% siltstone and argillite, and some fossil-bearing layers (Tur map unit). At the far eastern end of the S2 Reach, the Salmon River flows out of bedrock mountains, also mapped as Tur with small Tertiary basalt or lava (Tb) inclusions. But the dominant geology on the terrace surface near the River is a glacial outwash plain with underlying, relatively impermeable glacial till. The underlying, relatively impermeable glacial till, which is expected to dominate across most of the terrace surface near the River in S2, will restrict vertical movement of groundwater, resulting in seepage along river banks. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but the soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach have bedrock/glacial till at just a few inches (Kunamakst, Thimblepeak), or a cemented till layer at 2 to 4 feet depth capped by outwash sediments (Haas, Papac, Salmonriver, Matheny Creek, Stequehato), or glacial outwash substrate (Solduc). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Donkey Creek, Hoh, Riverwash, Udifluvents), but the riverine floodplain also includes some areas of silty alluvium on terraces (Queets). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock).

In this reach, like other riverine reaches, mapping indicates that most of the terrace areas upslope the 100-year floodplain are glacially influenced, with alluvium or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the terrace faces, forming seeps. Shallow, horizontal drainage of groundwater can cause landslides and soil sluffing from stormwater erosion impacts at the top of the terrace or from deep-seated rotational failures in saturated soil areas where the toe slope has been eaten away by the river. Sluffing from erosion and larger mass-wasting failures that send huge sediment loads into the river. This problem is consistent along the outside of river bends throughout the Reservation, particularly in the larger rivers with higher winter flows.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 12 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 12. Reach S2 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
5-Chitwhin medial silt loam	82.3	Medial silt loam	Formed in silty alluvium; On low river terraces and floodplains	21"-30"	>60"
9-Donkeycreek medial loam	16.9	Medial silt loam	Formed in loamy alluvium over gravelly glacial outwash; On outwash plains	>72"	14"-24" to stratification

13-**HAAS**-Kunamakst complex	64.9	Medial silt loam	Formed in alpine glacial till; On ground moraines	25"-44"	>60"
13-Haas-**KUNAMAKST** complex	Same as above	Loam	Formed in alpine glacial till derived from sedimentary and metasedimentary rock; On ground moraines	3"-6"	13"-23" to dense material
15-Hoh medial fine sandy loam	22.8	Medial silt loam	Formed in mixed alluvium; On low terraces and flood plains	>72"	40"-60" to stratification
22-**KYDAKA**-Copalisrock complex	9.2	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface	25"-45" to dense material
22-Kydaka-**COPALISROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	At soil surface	28"-38" to dense material
29-Mathenycreek medial silt loam	0.2	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	19"-26"	22"-42" to cemented layer
42-Papac medial silt loam	42.2	Gravelly medial silt loam	Formed in alpine glacial till; On ground moraines	13"-28"	21"-41" to dense material
45-Queets medial silt loam	362.2	Medial silt loam	Formed in silty alluvium; On terraces	>72"	>60"
46-**RIVERWASH**-Water-Udifluvents complex	143.9	Sandy, gravelly	Unstabilized sandy and gravelly deposits that are reworked by streams and rivers; In river valleys	Flooding	Flooding
46-Riverwash-**WATER**-Udifluvents complex	Same as above	Surface water	Open bodies of water, such as the Quinault River	Surface water	Surface water
46-Riverwash-Water-**UDIFLUVENTS** complex	Same as above	Sandy, gravelly	Formed in alluvium; In flood plains	12"-24"	>60"
48-**SALMONRIVER**-Kunamakst complex	10.2	Medial silt loam	Formed in alpine glacial till derived from sedimentary and metasedimentary rock; On ground moraines	28"-39"	38"-48" to placic horizon; 39"-51" to dense material
48-Salmonriver-**KUNAMAKST** complex	Same as above	Loam	Formed in alpine glacial till derived from sedimentary and metasedimentary rock; On ground moraines	3"-6"	13"-23" to dense material
52-Solduc very gravelly medial loam	187.0	Very gravelly medial sandy loam	Formed in glacial outwash; On glacial outwash plains or terraces and associated escarpments	>72"	>60"
57-Stequateho gravelly medial loam	103.9	Gravelly medial loam	Formed in alluvium over glacial outwash; On outwash terraces	30"-60"	47"-57" to stratification

58-**THIMBLEPEAK**-Haas complex	13.4	Gravelly medial silt loam	Formed in alpine glacial till; On ground moraines	9"-18"	>60"
58-Thimblepeak-**HAAS** complex	Same as above	Medial silt loam	Formed in alpine glacial till; On ground moraines	25"-44"	>60"
59-Udifluvents	96.1	Sandy, gravelly	Formed in alluvium; In flood plains	12"-24"	>60"

Gravel pits

Two gravel pits are mapped nearby, but none are within the SAA. The nearest gravel pit is on uplands 2,000 feet to the north near the eastern end of the S2 Reach, adjacent to a logging road.

Landslides

No landslides are mapped within this reach. There are potentially unstable areas are associated with undercut banks at the outside bends of the River, but there is no evidence of significant recent erosion in aerial photo records.

Tsunami

No tsunami impacts will occur this far upstream from the Ocean.

Critical Features

- Salmon River floodplain, critical salmonid habitat
- River feeds into the Salmon River Fish Hatchery facility at downstream end
- Forested wetlands in river floodplain; Forested uplands on adjacent terraces

Critical Habitats and Species[26]

- Salmon (in Salmon River): coho, chinook, steelhead, bull trout, cutthroat, fall chum are listed (by WDFW) as being present in the Salmon River
- River floodplain, forested and shrub wetlands
- Miscellaneous species listed within and near this Reach include: Pacific lamprey (2500 feet upstream from Hatchery); Olympic torrent salamander (near the eastern end of the Reach); bald eagle nest on the south side of the River in the floodplain about mid-Reach
- Spotted owl habitat mapped in the Townships covering this entire Reach

[26] Priority Habitats and Species Maps available in Quinault GIS system

- Marbled Murrelet habitat mapped in a section about a mile wide, mid-Reach

Shoreline Access

Access for the Reach S2 would be from small adjacent logging roads – some of which extend into the 100-year floodplain, or on foot. This section of the River might be navigable by boat, but probably only during periods of high water.

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S3: Salmon River, Reach 3 –North Reservation Boundary upstream to end of D-River (1.69 River Miles)

The Salmon River in Reach 3 (S3) is narrower, emanating from the mountainous area in the northeast Reservation. The active floodplain, including gravel and sand bars, ranges between 45 and 60 feet wide; the 100-year floodplain ranges from 300 to 800 feet wide.

Elevation at the River surface ranges from about 480 feet at downstream end of S2 up to about 560 feet at the upstream end, with a slope of about 1.3%. The edge of the 100-year floodplain is about 530 feet elevation at the downstream end of the Reach, and about 580 feet at the upslope end. The forested slopes within the SAA on both sides of the River range between about 500 and 800 feet elevation.

Geology Mapping

Unlike most of the Reservation, the surficial geology across the uplands and within the narrow 100-year floodplain at this location is mapped as undifferentiated Tertiary rocks (Tur), sandstone dominant with less than 40% siltstone and argillite, and some fossil-bearing layers. This mountainous area also includes some small Tertiary basalt or lava (Tb) inclusions (Figure 34, previous section). However, it can be assumed that the Salmon River floodplain would be mapped as more recent alluvium (Qa), if the mapping were more detailed. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but soil maps along this reach reflect Geology patterns discussed above. Soils mapped in this Reach in mountainous areas may be shallow over bedrock, formed in colluvium on steep slopes (Snahopish, Sockeye, Sollecks), or have bedrock/glacial till at just a few inches (Kunamakst, Thimblepeak). The river floodplain and low terraces will be recent alluvium (Udifluvents), but the channel is so narrow, they are not mapped separately.

In this reach, soil mapping indicates that most of the higher terrace surfaces outside of the river channel and floodplain are bedrock dominated with shallow soils. Some of these areas may also have shallow cemented layers, resulting in perched water as shallow as 8 inches, and wetland conditions. These impermeable substrates on steep slopes will cause fast runoff, with minimal infiltration. The effect of horizontal drainage of surface and groundwater and saturated soils at the top slopes will cause sluffing from erosion.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 13 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 13. Reach S3 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
49-**SNAHOPISH**-Sockeye-Solleks complex	4.0	Very gravelly medial loam	Formed in colluvium derived from alpine glacial till deposits; On dissected mountain slopes	>72"	>60"
49-Snahopish-**SOCKEYE**-Solleks complex	Same as above	Medial loam	Formed in colluvium derived from sedimentary and metasedimentary rock; On dissected mountain slopes	>72"; No ponding or flooding	>60"
49-Snahopish-Sockeye-**SOLLEKS** complex	Same as above	Very gravelly medial loam	Formed in colluvium derived from sedimentary and metasedimentary rock; On dissected mountain slopes	>72"; No ponding or flooding	>60"
58-**THIMBLEPEAK**-Haas complex	72.1	Gravelly medial silt loam	Formed in alpine glacial till; On ground moraines	9"-18"; No ponding or flooding	>60"
58-Thimblepeak-**HAAS** complex	Same as above	Medial silt loam	Formed in alpine glacial till; On ground moraines	25"-44"; No ponding or flooding	>60"

Gravel pits

No gravel pits are mapped nearby within the Reservation.

Landslides

No landslides are mapped within this reach.

Tsunami

No tsunami impacts will occur this far upstream from the Ocean.

Critical Features

- Salmon River floodplain, critical salmonid habitat
- Steeper side slopes along river channel, more susceptible to erosion
- Forested wetlands in river floodplain; forested uplands on adjacent slopes

Critical Habitats and Species[27]

- Salmon (in Salmon River): coho, chinook, steelhead, bull trout, cutthroat, fall chum are listed (by WDFW) as being present in the Salmon River
- River floodplain, forested and shrub wetlands
- Miscellaneous species listed within and near this Reach include: Pacific lamprey (1500 feet up a side tributary to the east); Riffle sculpin (1500 feet up a side tributary to the east).
- Spotted owl habitat mapped in the Townships covering this entire Reach
- Marbled Murrelet habitat mapped across the entire Reach

Shoreline Access

Access for the Reach S3 would be from NF 2446, which is located above the floodplain on a high side slope. There does not appear to be road access to the floodplain.

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4.3.5 Raft River and North Fork Raft Reaches

The Raft River is split into two reaches (Figure 35). R1 is the estuary area, starting at the confluence with the Pacific Ocean, and ending at the MHHW tide elevation upstream (1.19 miles). This represents the zone where salt water mixes with fresh water, and creates unique habitats and management conditions. The Raft River estuary is unique, beautiful and culturally important to the QIN. R2 extends upstream from the MHHW elevation to the eastern end of the designated D-River (11.90 River Miles). The river farther upstream is narrower with minimal floodplain.

The North Fork of the Raft River merges with the Raft about 3.5 river miles upstream from the Pacific Ocean. It has only one reach – extending 3.06 River Miles upstream from the Confluence with the Raft River, to the end of the broader, designated D-River section.

[27] Priority Habitats and Species Maps available in Quinault GIS system

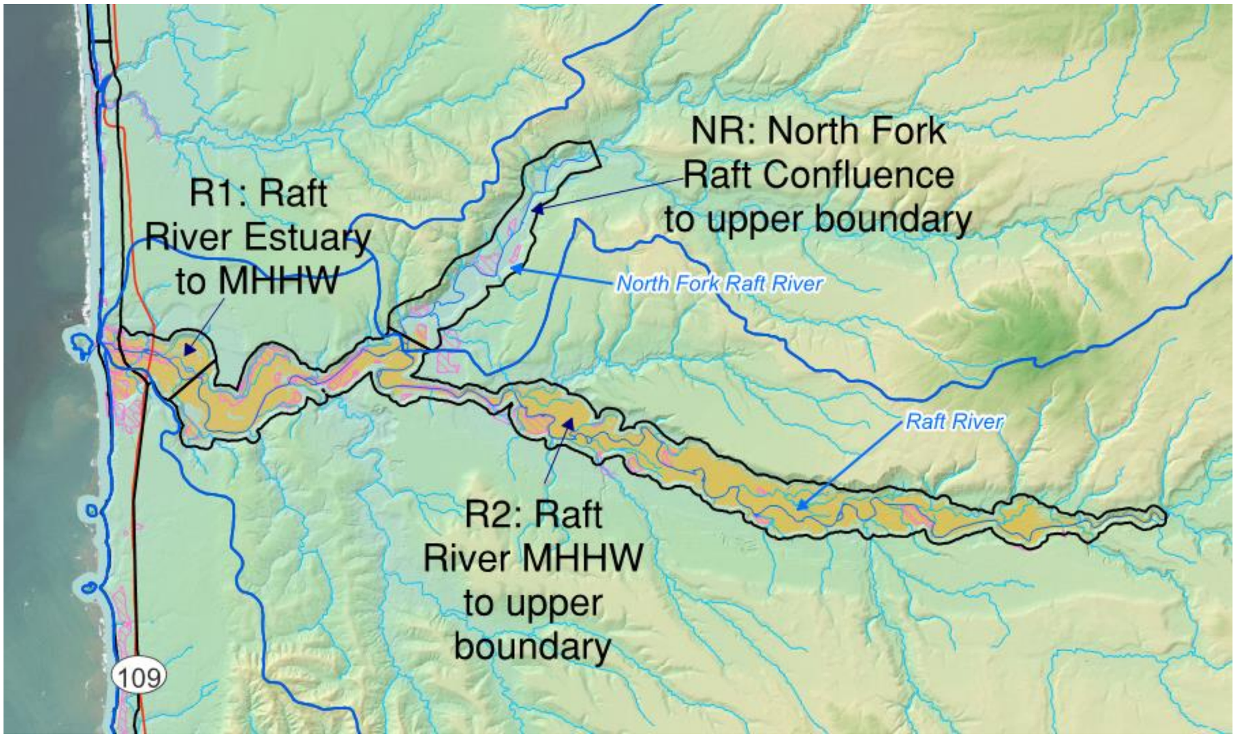

Figure 35. North Fork Raft and Raft River Reaches, NR1, R1, R2.

R1: Raft River, Reach 1 – Estuary to MHHW elevation (2.65 River Miles)

The mouth of the Raft River at the coast is an important cultural area for the QIN. The estuary is not as large or complex as the Queets estuary, but is still extensive with varied habitats and conditions. This estuary is primarily accessible by foot, and therefore is relatively pristine, despite showing evidence of some access by ATVs, and presence of European beach grass – a non-native plant. This Shoreline Area includes forested uplands; freshwater forested wetlands on oxbow islands; estuary flats on both sides of the River; beach areas extensively covered with large woody debris; lagoon embayments; and evidence of camping and recreational use by Tribal members.

Surface elevation surface ranges from 0 feet at the mouth of the River up to about 7.5 feet at the upper end of the Reach (extent of MHHW). The estuary and forested islands within the 100-year flood plain range between 5 and 20 feet elevation. The high terrace surface at the edge of the floodplain is about 80 to 100 feet elevation.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits) (Figure 36). The Raft River estuary floodplain is mapped as more recent alluvium (Qa). The headlands and islands to the west are mapped as Tertiary age siltstone with minor sandstone inclusions (Thsr map unit) and Quinault Formation, a feldspathic sandstone; sometimes fossil-bearing (Tqq map unit), indicating that the bluffs above the estuary are likely to be underlain by this same bedrock unit. However, it is also expected to be capped by densic glacial till.

The underlying, relatively impermeable till expected to dominate across on the terrace surface near the River within the R1 reach will restrict vertical movement of groundwater, resulting in seepage alongside slopes and river banks. Please refer to Digital Geology Map A-5 for details.

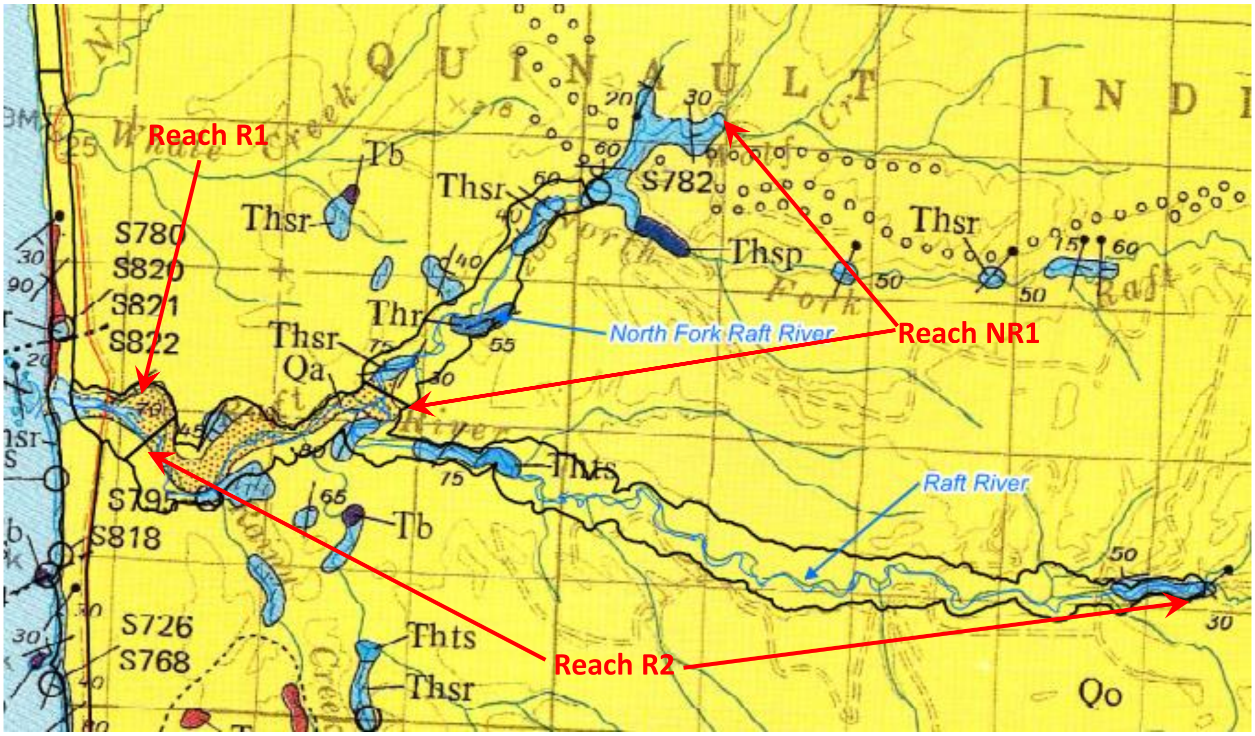

Figure 36. R1, R2 and NR1 Reaches Geology.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but soil maps along these reaches reflects Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 3 to 4 feet depth capped by outwash sediments (Mopang, Matheny Creek, Oyhut), or glacial outwash substrate (Calawah). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Udifluvents). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Chow-Chow). Some of the coastal estuary area is mapped as having well-drained sandy sediments (Westport, and Dune Land).

Soil mapping indicates that most of the terrace areas upslope the 100-year floodplain are glacially influenced, with alluvium or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the riverine terrace faces, forming seeps. At river bends, where soils are gradually eroded at toe slope by the river, the effect of horizontal drainage of groundwater and saturated soils at the top of the adjacent terrace is exacerbated, causing sluffing from erosion and larger mass-wasting failures that send huge sediment loads into the river. This problem is consistent along the outside of river bends throughout the Reservation, particularly in the larger rivers with higher winter flows.

Soils within the main river channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree. The lower terraces within the floodplain have older alluvium or lakebed sediments as a base, but are capped with more recent alluvium. Some of these areas closer to the River are mapped as wetlands, but some slightly higher elevation areas might flood periodically, but are not always wetland.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 14 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 14. Reach R1 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
5-Chitwhin medial silt loam	103.4	Medial silt loam	Formed in silty alluvium; On low river terraces and floodplains	21"-30"; No ponding, Rare flooding (Jan-Mar and Dec)	>60"
6-Chowchow peat	4.4	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Oct-Dec) No flooding	22"-38" to an abrupt textural change
29-Mathenycreek medial silt loam	0.85	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	19"-26"; No ponding or flooding	22"-42" to cemented layer
31-Mopang medial silt loam	9.9	Medial silt loam	Formed in gravelly glacial outwash; On outwash terraces	41"-51"; No ponding or flooding	42"-55" to cemented layer; 50"-65" to dense material
34-**MOPANG**-Calawah complex	17.7	Medial silt loam	Formed in glaciofluvial sediments; On outwash terraces on till plains	41"-51"; No ponding or flooding	42"-55" to cemented layer; 50"-65" to dense material
34-Mopang-**CALAWAH** complex	Same as above	Medial silt loam	Formed in gravelly glacial outwash; On escarpments on outwash terraces	>72"; No ponding or flooding	>60"

39-Oyhut complex	1.3	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	19"-36"; No ponding or flooding	25"-41" to cemented layer
60-Water	9.9	Surface water	Open bodies of water, such as the Quinault Lake	Surface water	Surface water
61-**WESTPORT** and Dune land soils	1.9	Fine sand	Formed in eolian sand; On dunes	>72"; No ponding or flooding	>60"
61-Westport and **DUNE LAND** soils	Same as above	sand	Formed in eolian sand; On dunes	No ponding or flooding	>60", tidal influence

Gravel pits

No gravel pits are mapped within the SAA, but there are five nearby – three to the north and two to the south, all more than 1,000 feet from the edge of the SAA. They appear to be associated with past logging, perhaps providing materials for building logging roads.

Landslides

No landslides are mapped within this reach. The only apparent potentially unstable areas are associated with periodic movement of the River, creating undercut banks at the outside bends of the River.

Tsunami

WaDNR 2010 and 2015 tsunami models do not provide detailed map information in this Reach on the Reservation. However, it is reasonable to assume that impacts from tsunami events would be comparable up the entire coast. This indicates the potential for severe inundation across the Raft River estuary and lower bluffs on both sides of the River, with wave and over-wash impacts of 20 to 30 feet elevation (almost to the confluence with the North Fork Raft), and main channel impacts up to 60+ feet elevation upriver – upstream of the confluence with the North Fork.

Critical Features

- Raft River Estuary, relatively pristine, critical salmonid habitat, important cultural area
- Evidence of historic impacts along north shore near an old oxbow which may contain cultural artifacts (Figure 37)
- Old State Route 109 Bridge remnants, which may have historic value

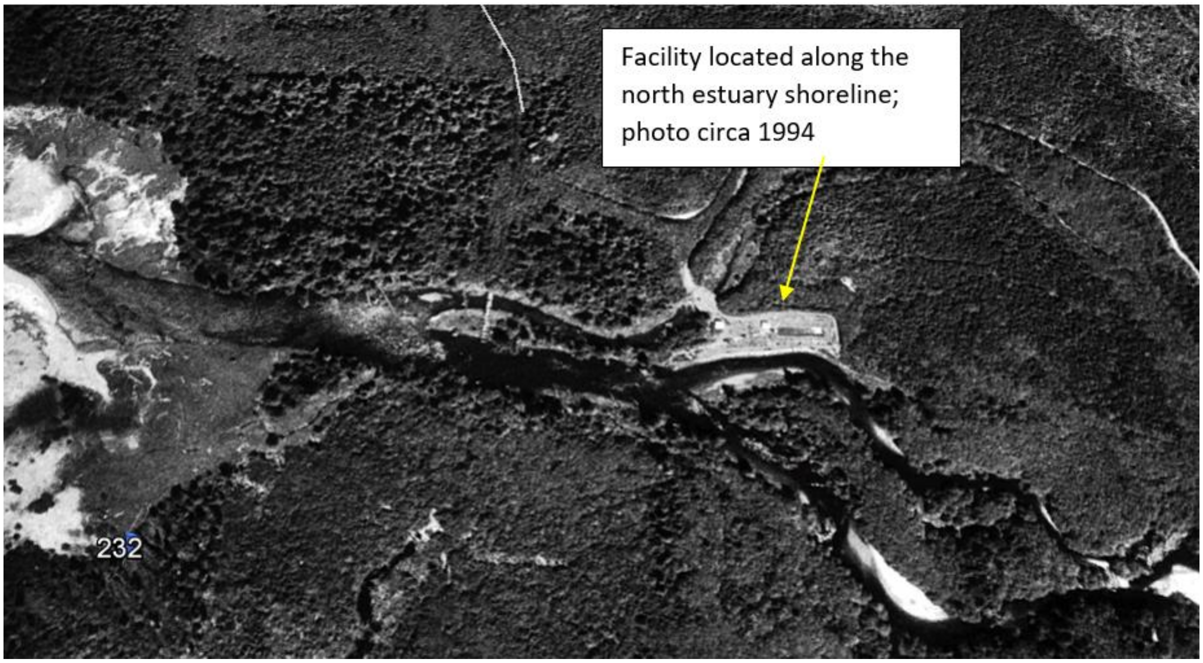

Figure 37. Facility along the north shore of R1, circa 1994.

Critical Habitats and Species[28]

- Salmon (Raft River): coho, steelhead, bull trout are listed (by WDFW) as being present in the Queets River
- Surf smelt are listed as spawning on sandy beaches, possibly within the estuary
- Estuaries, islands; forested and shrub wetlands

Shoreline Access

Access for the Raft River estuary is primarily by foot from the north end of the Old State Route 109 terminus (Cape Elizabeth Road), but there are apparently also access pathways available for ATVs. Beach access is not allowed by non-tribal members, unless they are accompanied by a Tribal representative.

R2: Raft River, Reach 2 – MHHW to east end of D-River (11.90 River Miles)

The Raft River in Reach 2 (R2) meanders widely. Downstream of the confluence with the North Fork, the floodplain is close to 3,000 feet wide. The open flow channel is about 90 feet wide, which expands to over 300 feet wide at river bends, including sand and gravel bars. Upstream of the confluence, the River is slightly narrower, with the open channel about 60 feet wide,

[28] Priority Habitats and Species Maps available in Quinault GIS system

expanding to about 150 feet at the river bends, and the floodplain ranging from 600 to 2,500 feet wide.

This reach includes forested uplands and freshwater forested wetlands within the 100-year floodplain, and logging roads extending into the floodplain at many locations. One of those logging roads bridges the Raft River about 2 miles upstream from the confluence with the North Fork.

Elevation at the River surface ranges from about 7.5 feet at downstream end of R2 up to 40 feet at the confluence with the North Fork Raft, and up to 180 feet at the upstream end of the Reach, at the end of the D-River section – a slope of 0.25%. The edge of the 100-year floodplain is at about 20 to 30 feet elevation at the downstream end of N2; at about 60 feet at the confluence with the North Fork Raft; and at about 200 feet at the upstream end of the D-River section. The top of the upland forested terraces adjacent to the floodplain within the SAA range from about 100 to 250 feet elevation, from downstream to upstream ends of the Reach.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands adjacent to the 100-year floodplain is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits) (Figure 36, previous section). Most of the Raft River floodplain is mapped as more recent alluvium (Qa), downstream from the confluence with the North Fork, but it is reasonable to assume that the entire floodplain is recent alluvium (Qa).

Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till on the terraces on both sides of the River, but there are small areas mapped as outcroppings of Tertiary age layered siltstones, sandstones, marine breccia and conglomerates (Thsr, Thts, and Thr map units), assumed to underlay the glacial till and outwash surfaces farther east.

The underlying, relatively impermeable glacial till, which appears to dominate across on the terrace surface near the River within the R2 reach will restrict vertical movement of groundwater, resulting in seepage along river terraces sidewalls. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but they do reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 3 to 4 feet depth capped by outwash sediments (Mopang, Matheny Creek, Papac, Southshore), or glacial outwash substrate (Calawah, Solduc). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Udifluvents), but the riverine floodplain also includes some areas of silty alluvium on terraces (Queets). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock, Moclips, Chow-Chow).

In this reach, like other riverine reaches, mapping indicates that most of the terrace areas upslope the 100-year floodplain are glacially influenced, with alluvium or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the terrace faces, forming seeps. Shallow, horizontal drainage of groundwater can cause landslides and soil sluffing from stormwater erosion impacts at the top of the terrace or from deep-seated rotational failures in saturated soil areas where the toe slope has been eaten away by the river.

Soils within the main river channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree. The lower terraces within the floodplain have older alluvium or lakebed sediments as a base, but are capped with more recent alluvium. Some of these areas closer to the River are mapped as wetlands, but some slightly higher elevation areas might flood periodically, but are not always wetland.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 15 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 15. Reach R2 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
5-Chitwhin medial silt loam	342.6	Medial silt loam	Formed in silty alluvium; On low river terraces and floodplains	21"-30"; No ponding, Rare flooding (Jan-Mar and Dec)	>60"
7-Chowchow-Water complex	121.52	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Oct-Dec) No flooding	22"-38" to an abrupt textural change
22-**KYDAKA**-Copalisrock complex	8.1	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface; Long, frequent ponding (Jan-Mar and Dec) No flooding	25"-45" to dense material
22-Kydaka-**COPALISROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	At soil surface; Long, frequent ponding (Jan-May and Nov-Dec) No flooding	28"-38" to dense material
23-**KYDAKA**-Moclips complex	1.5	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface; Long, frequent ponding (Jan-Mar and Dec) No flooding	25"-45" to cemented layer

23-Kydaka-**MOCLIPS** complex	Same as above	Mucky silt loam	Formed in silty glaciolacustrine deposits over stratified glacial outwash; On glacial outwash terraces	At soil surface to a depth of 2"; Long, frequent ponding (Jan-May and Dec) No flooding	8"-14" and 25"-40" to placic horizon
29-Mathenycreek medial silt loam	69.0	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	19"-26"; No ponding or flooding	22"-42" to cemented layer
31/32-Mopang medial silt loam	3.8	Medial silt loam	Formed in gravelly glacial outwash; On escarpments on outwash terraces	41"-51"; No ponding or flooding	42"-55" to cemented layer
34-**MOPANG**-Calawah complex	129.8	Medial silt loam	Formed in glaciofluvial sediments; On outwash terraces on till plains	41"-51"; No ponding or flooding	42"-55" to cemented layer
34-Mopang-**CALAWAH** complex	Same as above	Medial silt loam	Formed in gravelly glacial outwash; On escarpments on outwash terraces	>72"; No ponding or flooding	>60"
43-Papac medial silt loam	64.1	Gravelly medial silt loam	Formed in weathered glacial drift; On glacial terraces and till plains	13"-28"; No ponding or flooding	21"-41" to dense material
45-Queets medial silt loam	620.4	Medial silt loam	Formed in silty alluvium; On terraces	>72"; No ponding or flooding	>60"
52-Solduc very gravelly medial loam	141.8	Very gravelly medial sandy loam	Formed in glacial outwash; On glacial outwash plains or terraces and associated escarpments	>72"; No ponding or flooding	>60"
56-Southshore gravelly medial silt loam	9.2	Extremely gravelly medial silt loam	Formed in alpine glacial till; On outwash plains	41"-51"; No ponding or flooding	42"-62" to cemented layer

Gravel pits

Several gravel pits are located south of the R2 Reach, but only one is mapped within the Reach – on the south side of the floodplain about 3.5 miles upstream from the North Raft confluence. The gravel pit is no longer visible on Google Earth, and thus is assumed to have been a temporary facility – likely to support local road building activities.

Landslides

No landslides are mapped within this reach. There are potentially unstable areas are associated with periodic movement of the River, creating undercut banks at the outside bends of the River, but no obvious failures are visible on aerial photos within the Reach.

Tsunami

WaDNR 2010 and 2015 tsunami models do not provide detailed map information in this Reach on the Reservation. However, it is reasonable to assume that impacts from tsunami events would be comparable up the entire coast. This indicates the potential for inundation in the floodplain from wave and over-wash impacts at up to 20 to 30 feet elevation, and main channel impacts up to 60+ feet elevation upriver – upstream of the confluence with the North Fork Raft River.

Critical Features

- Raft River floodplain, critical salmonid habitat, variable meander channel more than ½ mile wide at certain sections
- Small bridge crossing the Raft about 2 miles upstream of the North Raft Confluence – one of the only ways to access areas north of the Raft
- Forested wetlands in river floodplain

Critical Habitats and Species[29]

- Salmon (Raft River): coho, steelhead, bull trout are listed (by WDFW) as being present in the Raft River
- River floodplain, forested and shrub wetlands
- Spotted owl habitat mapped in the Township starting about 1.25 miles upstream of the confluence of the North Raft River

Shoreline Access

Access for most of the Raft River in this reach is via logging roads or on foot. The river might be navigable by boat, but likely only during periods of high water. As mentioned previously, there is one bridge crossing in this reach, located about 1.25 miles upstream of the confluence.

NR1: North Raft River, Reach 1 – Confluence with the Raft River upstream to end of D-River (3.06 River Miles)

The North Fork Raft River has only one Reach (NR1), starting at the confluence with the Raft River and extending about 2 miles northeast to the confluence with Wolf Creek – the end of the D-River section. in Reach 2 (R2) meanders widely. The downstream section of NR1 meanders and has gravel and sand bars, with an open flow channel 100 to 150 feet wide. Farther upstream, the main channel becomes deeply incised, and has fewer large sand and gravel bars;

[29] Priority Habitats and Species Maps available in Quinault GIS system

the open flow channel in this area about 25 to 50 feet wide. However, the 100-year floodplain across the entire length of NR1 ranges between about 800 and 2,300 feet wide.

This reach includes both forested uplands and freshwater forested wetlands within the 100-year floodplain, and logging roads extending into the floodplain at several locations. Two of those logging roads apparently bridged the North Fork Raft River in the narrower incised sections in the past – the first crossing being about 1 mile, and the second about 1.5 miles upstream from the confluence with the Raft River. However, the bridges are not apparent in current photos; thus, they may have been removed or washed out.

Elevation at the North Fork Raft River surface ranges from about 40 feet at downstream end of NR1 up to 80 feet at the northeast end of the D-River – a slope of 0.25%. The edge of floodplain elevation appears to be about 60 feet at the downstream end of the Reach and 100 feet at the upstream end – about 20 feet higher than the main channel. The top of the upland forested terraces and slopes adjacent to the floodplain within the SAA range from about 100 to 240 feet elevation, from the downstream to upstream ends of the Reach.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands adjacent to the 100-year floodplain is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits) (Figure 36, previous section). Most of the Raft River floodplain is mapped as more recent alluvium (Qa), downstream from the confluence with the North Fork, but it is reasonable to assume that the entire floodplain is recent alluvium (Qa).

Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till on the terraces on both sides of the River, but there are small areas mapped as outcroppings of Tertiary age layered siltstones, sandstones, marine breccia and conglomerates (Thsr, Thts, and Thr map units), assumed to underlay the glacial till and outwash surface.

The underlying, relatively impermeable glacial till, which appears to dominate across on the terrace surface near the River within the R2 reach will restrict vertical movement of groundwater, resulting in seepage along river terraces sidewalls. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but do reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 2 to 4 feet depth capped by outwash sediments (Aabab, Mopang, Matheny Creek), or glacial outwash substrate (Calawah). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Udifluvents). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock, Moclips).

In this reach, like other riverine reaches, mapping indicates that most of the terrace areas upslope the 100-year floodplain are glacially influenced, with alluvium or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the riverine terrace faces, forming seeps. At river bends, where soils are gradually eroded at toe slope by the river, the effect of horizontal drainage of groundwater and saturated soils at the top of the adjacent terrace is exacerbated, causing sluffing from erosion and larger mass-wasting failures that send huge sediment loads into the river. This problem is consistent along the outside of river bends throughout the Reservation, particularly in the larger rivers with higher winter flows.

Soils within the main river channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree. The lower terraces within the floodplain have older alluvium or lakebed sediments as a base, but are capped with more recent alluvium. Some of these areas closer to the River are mapped as wetlands, but some slightly higher elevation areas might flood periodically, but are not always wetland.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 16 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 16. Reach NR1 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
1-Aabab medial silt loam	4.7	Medial silt loam	Formed in mixed sedimentary alluvium derived from sandstone and siltstone; On proglacial lakes	11"-28"; No ponding or flooding	>60"
5-Chitwhin medial silt loam	166.8	Medial silt loam	Formed in silty alluvium; On low river terraces and floodplains	21"-30"; No ponding, Rare flooding (Jan-Mar and Dec)	>60"
22-**KYDAKA**-Copalisrock complex	14.2	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface; Long, frequent ponding (Jan-Mar and Dec) No flooding	25"-45" to dense material
22-Kydaka-**COPALISROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	At soil surface; Long, frequent ponding (Jan-May and Nov-Dec) No flooding	28"-38" to dense material

23-**KYDAKA**-Moclips complex	15.3	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface; Long, frequent ponding (Jan-Mar and Dec) No flooding	25"-45" to cemented layer
23-Kydaka-**MOCLIPS** complex	Same as above	Mucky silt loam	Formed in silty glaciolacustrine deposits over stratified glacial outwash; On glacial outwash terraces	At soil surface to a depth of 2"; Long, frequent ponding (Jan-May and Dec) No flooding	8"-14" and 25"-40" to placic horizon
29-Mathenycreek medial silt loam	26.1	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	19"-26"; No ponding or flooding	22"-42" to cemented layer
31-Mopang medial silt loam	57.9	Medial silt loam	Formed in gravelly glacial outwash; On outwash terraces	41"-51"; No ponding or flooding	42"-55" to cemented layer
34-**MOPANG**-Calawah complex	76.5	Medial silt loam	Formed in glaciofluvial sediments; On outwash terraces on till plains	41"-51"; No ponding or flooding	42"-55" to cemented layer
34-Mopang-**CALAWAH** complex	Same as above	Medial silt loam	Formed in gravelly glacial outwash; On escarpments on outwash terraces	>72"; No ponding or flooding	>60"

Gravel pits

No gravel pits are mapped in or near this reach; however, a gravel pit is visible in aerial photos just at the edge of the SAA east of the River, about a mile north from the downstream end of the Reach. It appears to be associated with building a logging road.

Landslides

No landslides are mapped within this reach. There are potentially unstable areas are associated with periodic movement of the River, creating undercut banks at the outside bends of the River, but no obvious failures are visible on aerial photos within the Reach.

Tsunami

WaDNR 2010 and 2015 tsunami models do not provide detailed map information in this Reach on the Reservation. However, it is reasonable to assume that impacts from tsunami events would be comparable up the entire coast. This indicates the potential for inundation in the floodplain from wave and over-wash impacts at up 20 to 30 feet elevation, and main channel impacts up to 60+ feet elevation upriver, which may extend upstream into NR1 from the confluence with the Raft River.

Critical Features

- North Fork Raft River floodplain, critical salmonid habitat, forested wetlands in river floodplain

- Possibly two small bridge crossings over the North Fork Raft about 1 and 1.5 miles upstream of the Raft confluence, providing access to a relatively remote part of the Reservation

Critical Habitats and Species[30]

- Salmon (North Fork Raft River): coho and steelhead are listed (by WDFW) as being present in the North Fork Raft River
- River floodplain, forested and shrub wetlands
- Spotted owl habitat mapped in the Township starting at the far north end of the Reach.

Shoreline Access

Access for most of the North Fork Raft River in this reach is via logging roads or on foot. The river might be navigable by boat, but likely only during periods of high water. As mentioned previously, there are possibly two bridge crossings in this reach, located about 1 and 1.5 miles upstream of the confluence with the Raft River.

4.3.6 Quinault River Reaches

The Quinault River is the largest river system within the Reservation, and is split into four reaches (Figure 38).

QN1 is the estuary area, starting at the confluence with the Pacific Ocean, and ending at the MHHW tide elevation upstream (2.57 miles). This represents the zone where salt water mixes with fresh water, and creates unique habitats and management conditions. This reach also includes the City of Taholah – the seat of Tribal Government.

QN2 extends upstream from the MHHW elevation to a bend in the River just downstream of where the combined flows of Chow-Chow Creek and Cook Creek enter the River (near Chow-Chow Prairie, 14.75 miles). This area is described as the upstream limit of Tribal commercial fishing, and happens to be the outflow of Cook Creek – which supports a fish hatchery upstream. The Quinault River farther upstream can still be fished, but it is shallower with less flow, and more difficult to navigate in a boat, making it less desirable for commercial fishing.

QN3 starts at the Chow-Chow and extends upstream 15.41 miles to where the River narrows significantly about ¾ miles downstream from the U.S. Highway 101 Bridge. This section of the River is shallower with many sand and gravel bars.

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[30] Priority Habitats and Species Maps available in Quinault GIS system

QN4 starts where the River narrows and extends upstream to the where the River flows out of Lake Quinault (1.72 miles).

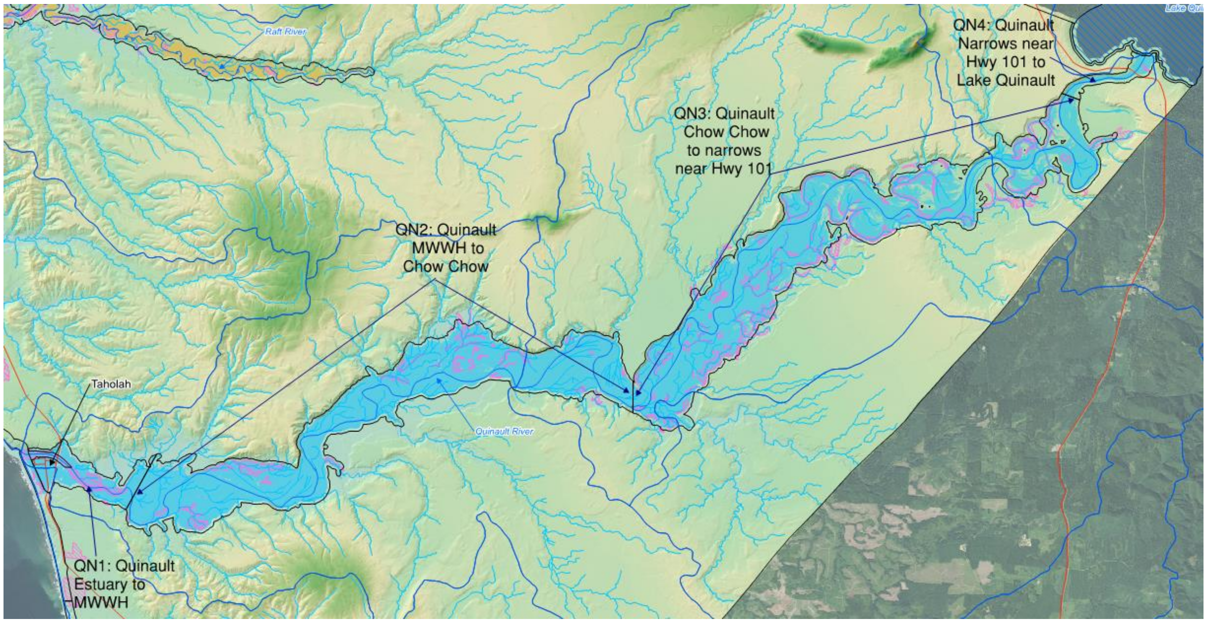

Figure 38. Quinault River Reaches, QN1, QN2, QN3 and QN4.

QN1: Quinault River, Reach 1 – Estuary to MHHW elevation (2.57 River Miles)

The mouth of the Quinault River west of the State Route 109 Bridge is constricted by development at Taholah – built on fill over what was once an estuary surface along the south side of the River mouth (Figure 39). The river bank at Taholah near the River mouth and edge of the beach along the coast to the west are armored, and diked, to protect the village during periods of flooding and high tides. Even so, sea level rise has already started to impact lower areas, and plans are being developed to move the village to high ground outside of the floodplain.

Because of this constriction and development, the estuary near the River mouth is minimal, and mostly limited to what occurs within the banks of the main flow channel and minor oxbow river features in the tidal area. The floodplain terrace north of the River within QN1 east of the bridge is mostly forest and shrub vegetation, and includes some freshwater wetlands. The State Route 109 Bridge over the Quinault River provides the primary access from the south to areas between the Raft River and the Quinault River on the Reservation. This is the only bridge over the Quinault River between Taholah and U.S. Highway 101 at the far eastern end of the Reservation, over 20 miles away.

Taholah is the seat of Tribal Government, and some government facilities are located within the floodplain areas, but most planning, resource management and health facilities are located on uplands to the south and southeast. The Taholah Village Wastewater Treatment Plant is located upslope, outside of the floodplain, east of the highway and south of the River. It is described as serving a resident population of approximately 1,500 people. It was constructed in 2006 with a design flow of 0.2 mgd, and was improved in 2009 to include a UV disinfection system, which discharges treated effluent to groundwater via rapid infiltration basin[31].

Figure 39. View of Taholah and mouth of the Quinault from the north, showing some of the village's critical infrastructure and facilities.

Elevation at the River main flow channel surface ranges from 0 feet at the mouth of the River up to about 7.5 feet at the upper end of the Reach (extent of MHHW). The edge of the 100-year floodplain in QN1 is about 20 to 30 feet elevation. The top of the forested terraces on the high bluffs above the 100-year flood plain are as high as 140 feet elevation near the mouth, but drops to about 40 feet elevation on top of an old riverine terrace along the north side of the River about a mile inland from the Coast. Most of the Taholah residential area and the water front businesses and fish processing facilities are at 10 to 20 feet elevation – highly susceptible to tsunami events and flooding during periods of king tides in combinations with high rainfall during winter months.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits). The Quinault main channel and

[31] Background on Sewage Treatment Plant: (https://www3.epa.gov/region10/pdf/permits/npdes/wa/taholah_fs.pdf).

floodplain is mapped as more recent alluvium (Qa). Bluffs along the coast and mostly along the north shore of the River are mapped as outcrops of Tertiary age layered siltstones, sandstones and conglomerates (Tqq, Thsr, Thts) and volcanic (Tb) rocks.

A relatively impermeable glacial till is expected to overlay the bedrock in many places on the terrace and bluff surfaces within the QN1 reach. These layers will restrict vertical movement of groundwater, resulting in seepage along river banks from the top of the bluff faces. Please refer to Digital Geology Map A-5 for details.

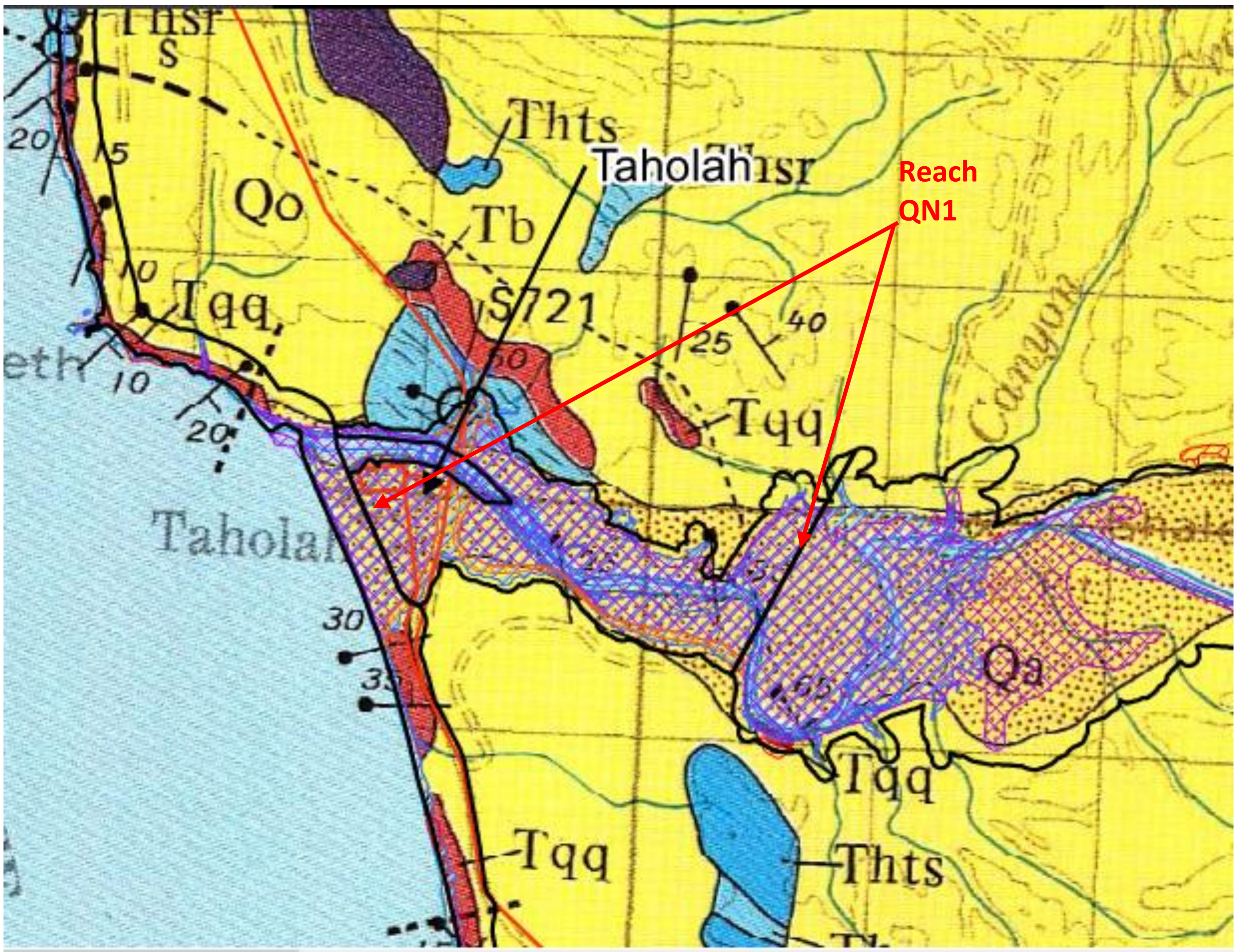

Figure 40. Reach QN1 geology map.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 2 to 4 feet depth capped by outwash sediments (Aabab, Mopang, Matheny Creek, Oyhut, Papac), or glacial outwash substrate (Calawah). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Hoh, Udifluvents). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock, Chow-Chow).

In this reach, mapping indicates that most of the higher terrace surfaces outside of the river channel and floodplain are glacially influenced, with alluvium, loess or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth or overlaying sedimentary bedrock. Some of these areas have shallow cemented layers, resulting in perched water as shallow as 8 inches, and wetland conditions. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the riverine terrace and bluff faces, forming seeps. At river bends, where soils are gradually eroded at toe slope by the river, the effect of horizontal drainage of groundwater and saturated soils at the top of the adjacent terrace is exacerbated, causing sluffing from erosion and larger mass-wasting failures that send huge sediment loads into the river. This problem is consistent along the outside of river bends throughout the Reservation, particularly in the larger rivers with higher winter flows.

Soils within the main river channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree. The lower terraces within the floodplain have older alluvium or lakebed sediments as a base, but are capped with more recent alluvium. Some of these areas closer to the River are mapped as wetlands, and some slightly higher elevation areas might flood periodically, but are not always wetland.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 17 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 17. Reach QN1 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
1-Aabab medial silt loam	27.3	Medial silt loam	Formed in mixed sedimentary alluvium derived from sandstone and siltstone; On proglacial lakes	11"-28"; No ponding or flooding	>60"
3-Calawah medial silt loam	7.4	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	>72"; No ponding or flooding	>60"
5-Chitwhin medial silt loam	241.6	Medial silt loam	Formed in silty alluvium; On low river terraces and floodplains	21"-30"; No ponding, Rare flooding (Jan-Mar and Dec)	>60"

6-Chowchow peat	19.9	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Oct-Dec) No flooding	22"-38" to a textural change
7-Chowchow-Water complex	5.1	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Oct-Dec) No flooding	22"-38" to an abrupt textural change
15-Hoh medial fine sandy loam	163.7	Medial silt loam	Formed in mixed alluvium; On low terraces and flood plains	>72"; No ponding, Brief occasional flooding (Jan-Mar and Dec)	40"-60" to stratification
22-**KYDAKA**-Copalisrock complex	0.8	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface; Long, frequent ponding (Jan-Mar and Dec) No flooding	25"-45" to dense material
22-Kydaka-**COPALISROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	At soil surface; Long, frequent ponding (Jan-May and Nov-Dec) No flooding	28"-38" to dense material
29-Mathenycreek medial silt loam	59.7	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	19"-26"; No ponding or flooding	22"-42" to cemented layer
33-**MOPANG**-Calawah complex, 15-35%	14.0	Medial silt loam	Formed in gravelly glacial outwash; On outwash terraces	41"-51"; No ponding or flooding	42"-55" to cemented layer
33-Mopang-**CALAWAH** complex	Same as above	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	>72"; No ponding or flooding	>60"
34-**MOPANG**-Calawah complex, 35-65%	17.2	Medial silt loam	Formed in glaciofluvial sediments; On outwash terraces on till plains	41"-51"; No ponding or flooding	42"-55" to cemented layer
34-Mopang-**CALAWAH** complex	Same as above	Medial silt loam	Formed in gravelly glacial outwash; On escarpments on outwash terraces	>72"; No ponding or flooding	>60"
39-Oyhut complex	4.6	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	19"-36"; No ponding or flooding	25"-41" to cemented layer
42-Papac medial silt loam, 8-30%	5.8	Gravelly medial silt loam	Formed in alpine glacial till; On ground moraines	13"-28"; No ponding or flooding	21"-41" to dense material
43-Papac medial silt loam, 30-65%	30.2	Gravelly medial silt loam	Formed in weathered glacial drift; On glacial terraces and till plains	13"-28"; No ponding or flooding	21"-41" to dense material

Gravel pits

Two gravel pits are mapped at the north edge of the QN1 SAA; one near J.B. McCrory Road, which accesses a reservoir north of the River, and the other near the northeast corner of the SAA on a logging road, apparently associated with past logging, perhaps providing materials for building roads. Neither appears to be currently active.

Landslides

No landslides are mapped within this reach. The only apparent potentially unstable areas are associated with bends in the River, creating undercut banks at the outside of the bend.

Tsunami

WaDNR 2010 and more recent 2015 tsunami models (Figure 41) provide detailed map information in this area on the Reservation. These models indicate the potential for severe inundation across the Quinault mouth and low areas south of the River, with wave and over-wash impacts of 20 to 30 feet elevation (covering most of Taholah and the QN1 100-year floodplain), and main channel impacts up to 60+ feet elevation upriver – upstream almost the confluence with Cook and Chow-Chow Creeks. Tsunami models indicate that a tsunami assumed to be at least 30 to 40 feet high would wash up the bluff faces. These waves would

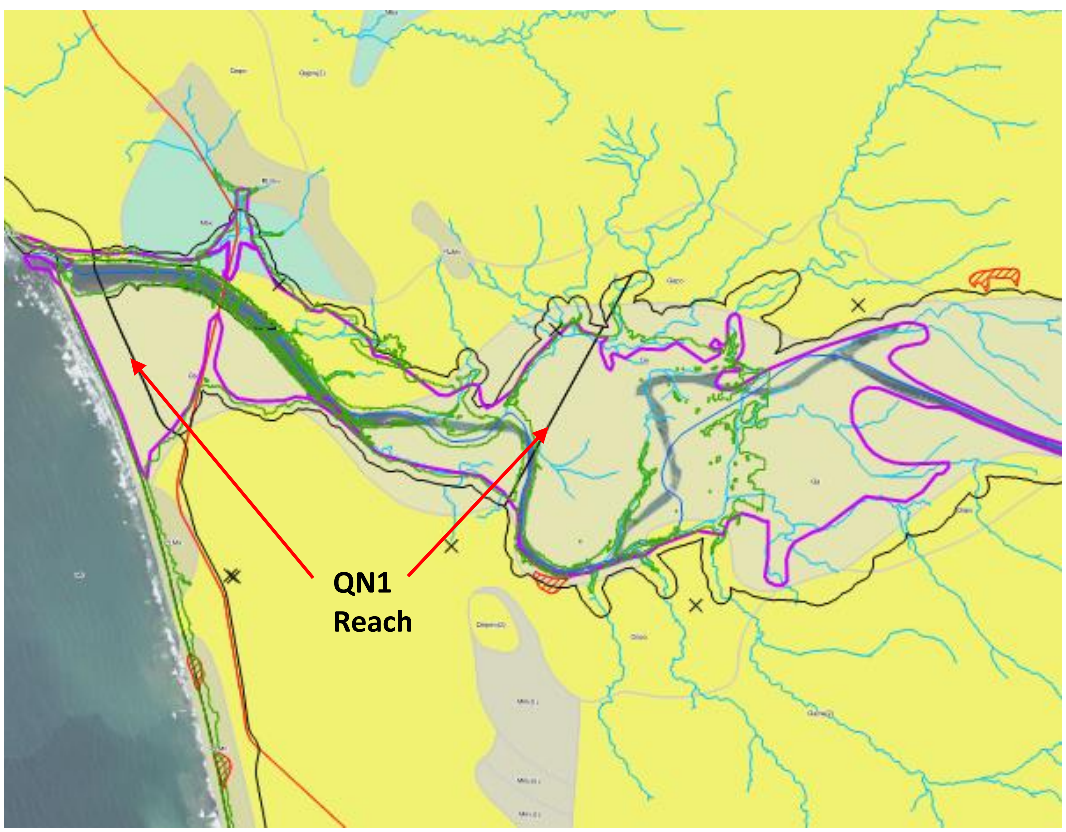

Figure 41. Tsunami Inundation at QN1 Reach: Green line is perimeter of inundation for WaDNR 2015 model; purple line is inundation perimeter for DGER 2010 model.

inundate the floodplain and overtop some bluffs along this Reach, and would potentially overtop or damage the State Route 109 Bridge (about 35 to 40 feet elevation) at the Quinault River crossing. More detailed information about the tsunami modeling scenarios is provide in Section 3.3[32]

Critical Features

- Taholah village, primary urban area on the Reservation and seat of Tribal Government
- Taholah School District (Elementary, Middle and High School)
- Quinault River, critical salmonid habitat, largest river on the Reservation
- Quinault Street:
    - Sea-wall on south shore of River in the floodplain
    - Quinault Street gas station – mini-mart and restaurant
    - Quinault Pride seafood wholesaler plant at Quinault River
    - Quinault Community Center building
- State Route 109 Bridge at the Quinault River, providing primary access to area between the Quinault and Raft Rivers from points south
- Taholah sewage lagoons, located at the western edge of the SAA, about 1000 feet south of the River and about 200 feet from the edge of vegetation at the beach
- Sewage treatment plant, located in the SAA southeast of the bridge

Critical Habitats and Species[33]

- Salmon (Quinault River): coho, chinook, steelhead, sockeye, bull trout, pink salmon, cutthroat, fall chum are listed (by WDFW) as being present in the Quinault River
- Estuaries, islands; forested and shrub wetlands
- One bald eagle nest on uplands north of the Quinault in the floodplain
- Osprey nest in the floodplain at the east end of the QN1 Reach
- Reticulate sculpin and Olympic mudminnow documented in the SAA near the northeast corner of QN1

[32] Cascadia scenario 1A: Tsunami hazard map of the southern Washington coast—Modeled tsunami inundation from a Cascadia subduction zone earthquake, by T. J. Walsh, C. G. Caruthers, A. C. Heinitz, E. P. Myers III, A. M. Baptista, G. B. Erdakos, and R. A. Kamphaus. 2000. 26 x 52 color sheet, scale 1:100,000, with 12 p. text.

DESCRIPTION Cascadia scenario 1A are areas inundated by a **moderately high** runup from the modeled Cascadia subduction zone tsunami.

Cascadia scenario 1A with asperity: Tsunami hazard map of the southern Washington coast—Modeled tsunami inundation from a Cascadia subduction zone earthquake, by T. J. Walsh, C. G. Caruthers, A. C. Heinitz, E. P. Myers III, A. M. Baptista, G. B. Erdakos, and R.A. Kamphaus. 2000. 26 x 52 color sheet, scale 1:100,000, with 12 p. text.

DESCRIPTION Cascadia scenario 1A with asperity are areas inundated by a **high** runup from the modeled Cascadia subduction zone tsunami.

[33] Priority Habitats and Species Maps available in Quinault GIS system

Shoreline Access

- Access for most of the Quinault River floodplain is from Taholah, by boat, by car along the roads paralleling the shoreline, and on foot. Quinault Street which runs along the top of the sea wall at the River becomes a dirt road extending out onto the sand spit at the River mouth to the west. Cuitan Street is the second road in from the River within Taholah, but extends east of State Route 109 to become the shoreline road. Beach access is not allowed by non-tribal members, unless they are accompanied by a Tribal representative.

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QN2: Quinault River, Reach 2 –MHHW upstream to Chow Chow (14.75 River Miles)

The Quinault River in Reach 2 (QN2) meanders significantly. It has a wide 100-year floodplain, as much as 6,800 feet across at some locations. The open flow section of the River in this reach is about 300 to 350 feet across, including the broad gravel and sand bars in the main channel. This reach meanders many miles through relatively undeveloped forest lands, and includes forested uplands and freshwater forested wetlands within the 100-year floodplain, and many old logging roads extending onto the floodplain terrace.

Elevation at the River surface ranges from about 7.5 feet at downstream end of Q1 up to about 70 feet at the upstream end of the Reach, near the confluence with Cook Creek and Chow-Chow Creek. The edge of the floodplain at the downstream end of QN2 is about 20 to 30 feet, and at the far upstream end of the Reach is about 80 to 90 feet elevation. The top of the upland forested terraces adjacent to the floodplain within the SAA at the west end are about 50 feet north of the River and about 120 feet south of the River. The upland terraces at the far east end are at about 140 feet elevation north of the River and as high as 280 feet south of the River.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands adjacent to the 100-year floodplain is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits) (Figure 42). Most of the Quinault floodplain is mapped as more recent alluvium (Qa). Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till in the broad plains on both sides of the River. Aside from a small area at the far southwest end of the SAA mapped as Tertiary sandstone and siltstone (Thts, Thsr), and Quinault Formation feldspathic sandstone (Tqq), there are no bedrock outcrops mapped along this Reach.

The underlying, relatively impermeable glacial till, which appears to dominate across on the terrace and upland surfaces near the River within the QN2 reach will restrict vertical movement of groundwater, resulting in seepage along river banks. Please refer to Digital Geology Map A-5 for details.

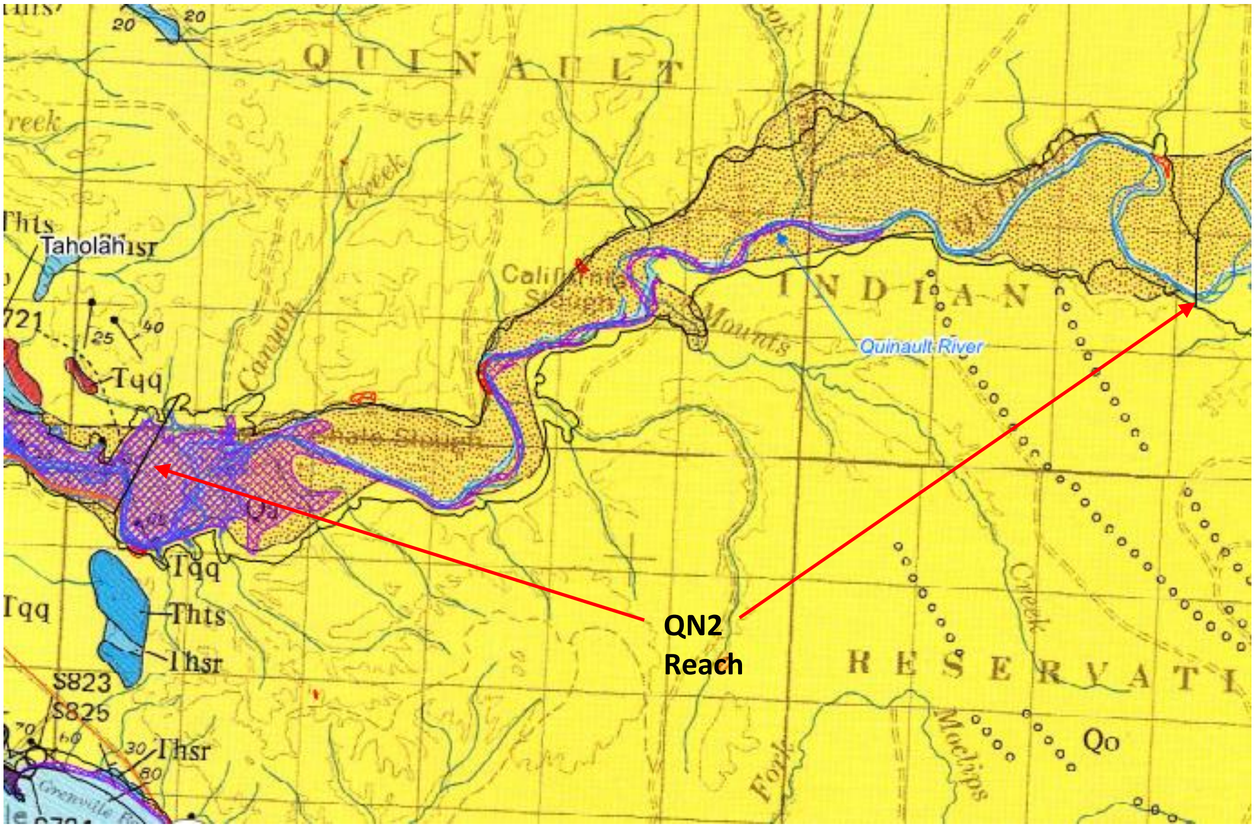


Figure 42. Geology of QN2 Reach

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface. In this reach, like other riverine reaches in the Reservation, mapping indicates that most of the higher terrace surfaces outside of the river channel and floodplain are glacially influenced, with alluvium, loess or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. Underlying sedimentary bedrock is mapped only in one small area near the northwest end of the SAA

The soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 2 to 4 feet depth capped by outwash sediments (Aabab, Mopang, Matheny Creek, Oyhut, Papac), or glacial outwash substrate (Calawah), or clay (O'Brien). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Donkey Creek, Hoh, Udifluvents). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock, Chow-Chow, Moses Prairie).

Mapping indicates that most of the terrace areas upslope the 100-year floodplain are glacially influenced, with alluvium or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. In some areas with shallow cemented layers, perched water will occur as shallow as 8 inches – potential wetland conditions. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the riverine terrace faces, forming seeps. Shallow, horizontal drainage of groundwater can cause landslides and soil sluffing from stormwater erosion impacts at the top of the terrace or from deep-seated rotational failures in saturated soil areas where the toe slope has been eaten away by the river.

Soils within the main river channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree. The lower terraces within the floodplain have older alluvium or lakebed sediments as a base, but are capped with more recent alluvium. Some of these areas closer to the River are mapped as wetlands, but some slightly higher elevation areas might flood periodically, but are not always wetland.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 18 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 18. Reach QN2 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
1-Aabab medial silt loam	27.7	Medial silt loam	Formed in mixed sedimentary alluvium derived from sandstone and siltstone; On proglacial lakes	11"-28"; No ponding or flooding	>60"
3-Calawah medial silt loam	16.2	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	>72"; No ponding or flooding	>60"
5-Chitwhin medial silt loam	2481.0	Medial silt loam	Formed in silty alluvium; On low river terraces and floodplains	21"-30"; No ponding, Rare flooding (Jan-Mar and Dec)	>60"
6-Chowchow peat	60.6	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Oct-Dec) No flooding	22"-38" to a textural change
7-Chowchow-Water complex	239.6	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Oct-Dec) No flooding	22"-38" to an abrupt textural change
9-Donkeycreek medial loam	125.6	Medial silt loam	Formed in loamy alluvium over gravelly glacial outwash; On outwash plains	>72"; No ponding or flooding	14"-24" to stratification
15-Hoh medial fine sandy loam	1480.6	Medial silt loam	Formed in mixed alluvium; On low terraces and flood plains	>72"; No ponding, Brief occasional	40"-60" to stratification

				flooding (Jan-Mar and Dec)	
22-**KYDAKA**-Copalisrock complex	54.4	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface; Long, frequent ponding (Jan-Mar and Dec) No flooding	25"-45" to dense material
22-Kydaka-**COPALISROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	At soil surface; Long, frequent ponding (Jan-May and Nov-Dec) No flooding	28"-38" to dense material
29-Mathenycreek medial silt loam	58.4	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	19"-26"; No ponding or flooding	22"-42" to cemented layer
31-Mopang medial silt loam, 15-35%	7.0	Medial silt loam	Formed in gravelly glacial outwash; On outwash terraces	41"-51"; No ponding or flooding	42"-55" to cemented layer
32-Mopang medial silt loam, 35-65%	53.1	Medial silt loam	Formed in gravelly glacial outwash; On escarpments on outwash terraces	41"-51"; No ponding or flooding	42"-55" to cemented layer
34-**MOPANG**-Calawah complex	105.7	Medial silt loam	Formed in glaciofluvial sediments; On outwash terraces on till plains	41"-51"; No ponding or flooding	42"-55" to cemented layer
34-Mopang-**CALAWAH** complex	Same as above	Medial silt loam	Formed in gravelly glacial outwash; On escarpments on outwash terraces	>72"; No ponding or flooding	>60"
35-Mosesprairie peat	31.8	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Nov-Dec) No flooding	50"-80" to textural change
38-O'Brien medial silt loam	2.8	Clay loam	Formed in loess over gravelly glacial outwash derived from igneous and metamorphic rock; On outwash terraces	>72"; No ponding or flooding	26"-42" to stratification
39-Oyhut complex	11.4	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	19"-36"; No ponding or flooding	25"-41" to cemented layer
42-Papac medial silt loam, 8-30%	9.0	Gravelly medial silt loam	Formed in alpine glacial till; On ground moraines	13"-28"; No ponding or flooding	21"-41" to dense material
43-Papac medial silt loam, 30-65%	176.0	Gravelly medial silt loam	Formed in weathered glacial drift; On glacial terraces and till plains	13"-28"; No ponding or flooding	21"-41" to dense material
44-Pits, gravel	6.2	Gravel	Open excavations from which soil and underlying material have been removed and used as gravel and cobbles; Till plains	No ponding or flooding	>60”
46-**RIVERWASH**-Water-	505.3	Sandy, gravelly	Unstabilized sandy and gravelly deposits that are	No ponding, Very long, frequent flooding (Jan-Jul and Oct-Dec)	Flooding

Udifluvents complex			reworked by streams and rivers; In river valleys		
46-Riverwash-**WATER**-Udifluvents complex	Same as above	Surface water	Open bodies of water, such as the Quinault River	Surface water	Surface water
46-Riverwash-Water-**UDIFLUVENTS** complex	Same as above	Sandy, gravelly	Formed in alluvium; In flood plains	12"-24"; No ponding, Brief, frequent flooding (Jan-Apr and Nov-Dec)	>60"
59-Udifluvents	5.8	Sandy, gravelly	Formed in alluvium; In flood plains	12"-24"; No ponding, Brief, frequent flooding (Jan-Apr and Nov-Dec)	>60"

<u>Gravel pits</u>

Nine gravel pits are mapped in or near this Reach. The ones mapped nearby are mostly more than 500 feet from the edge of the SAA, aside from one that is directly overlaying the SAA boundary about 3.5 miles from the western end of QN2. Three are mapped within the SAA, all located at the same location on the floodplain north of the River in an old oxbow area about 3 miles from the eastern end of QN2. These three gravel pits are still apparent on aerial photos, and two of the three appear to be full of water. The pits appear to be associated with logging, perhaps providing materials for building nearby roads.

<u>Landslides</u>

Five landslides are mapped within or directly adjacent to this reach. Three of the five were caused or exacerbated by a logging road. Two were caused by river meanders eating away a toe slope and destabilizing the slope above (Figures 43 and 44).

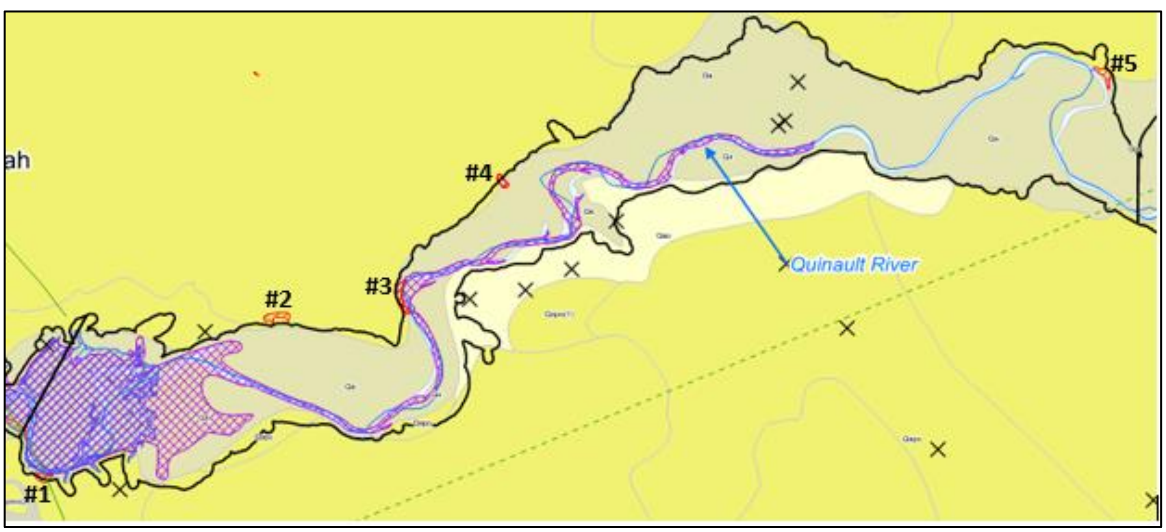
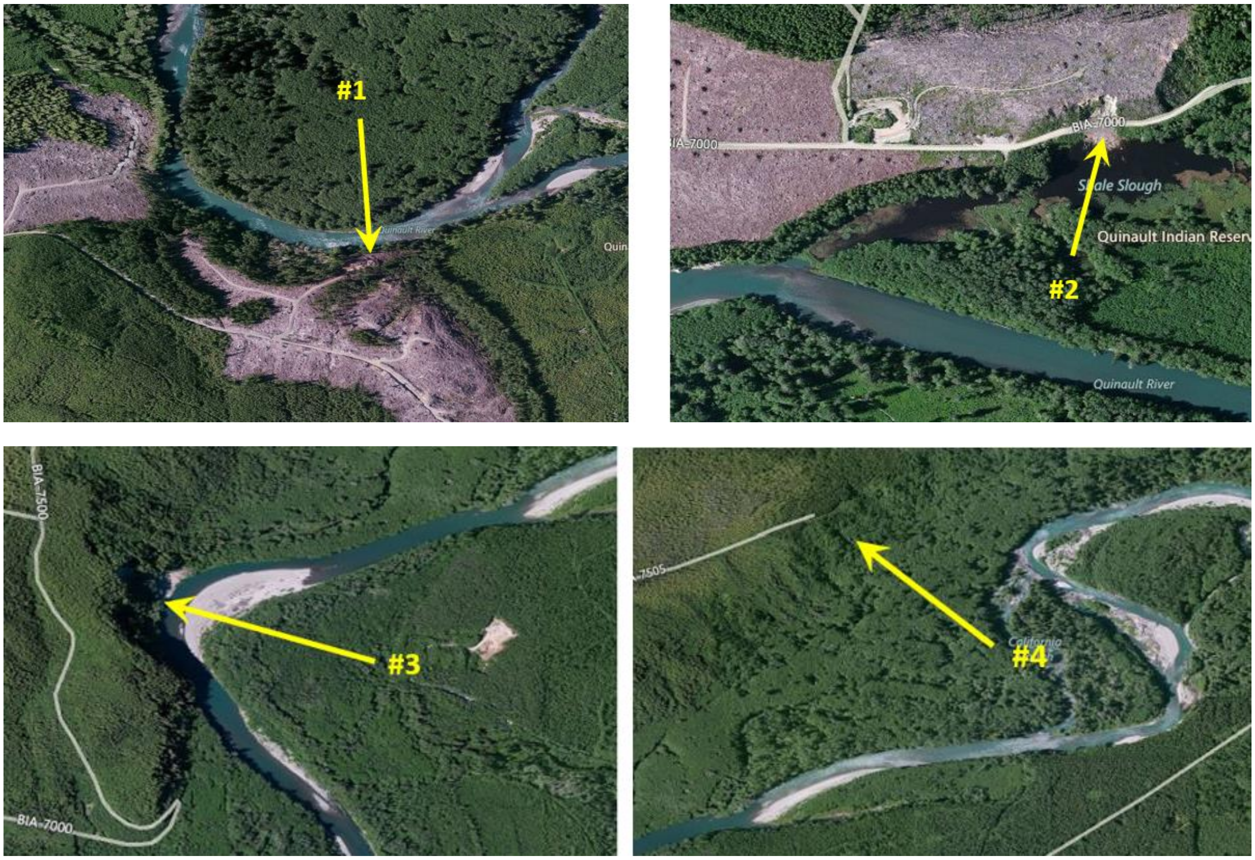


Figure 43. Tsunami impacts in QN2 (purple crosshatch), and landslides (marked with x) mapped along QN2, numbered to reference photos to follow.



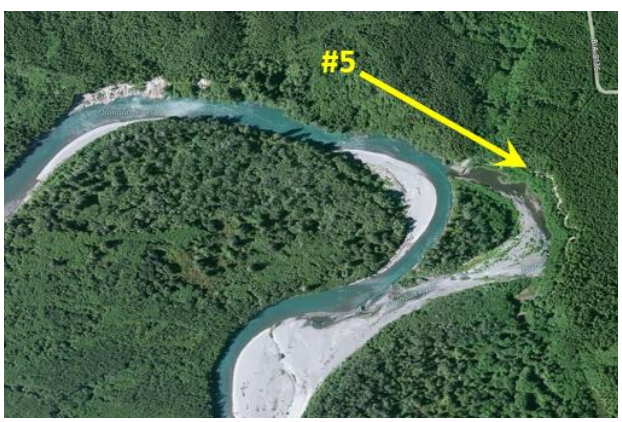


Figure 44. Five landslides mapped in QN2 Reach. #1, 2 and 4 were exacerbated by a logging road; the others by river erosion at a meander bend.

Tsunami

WaDNR 2010 and 2015 tsunami models indicate the potential for severe inundation across the Queets River estuary and lower bluffs north of the River, covering the entire floodplain up to 1.5 miles above the western end of QN2 (3.5 miles inland from the ocean), with wave and over-wash impacts of 20 to 30 feet elevation (Figure 43). In addition, the models indicate main channel impacts up to 60+ feet elevation upriver – almost to the eastern end of QN2.

Critical Features

- Quinault River floodplain; critical salmonid habitat; floodplain more than a mile wide in some areas
- High bluffs adjacent to the River which are susceptible to undercutting and failure under natural conditions at river bends.
- Extensive high quality oxbow-island forested wetlands in river floodplain

Critical Habitats and Species[34]

- Salmon (Quinault River): coho, chinook, steelhead, sockeye, bull trout, pink salmon, cutthroat, fall chum are listed (by WDFW) as being present in the Quinault River
- River floodplain, forested and shrub wetlands
- Eight bald eagle nests: Three near the western end of QN2; five randomly located along the River to the east
- One osprey nest north of the River close to the western end of QN2.
- Reticulate sculpin documented north of the River on the floodplain about a mile from the western end of QN2

Shoreline Access

Access for most of the QN2 Reach is from the well-developed BIA road network on both sides of the River, which extends into the floodplain to the River edge at several locations, or via boat.

QN3: Quinault River, Reach 3 – Chow-Chow to Narrows near U.S. Highway 101 Bridge (15.41 River Miles)

The Quinault River in Reach 3 (QN3) is shallower with less flow than the QN2 reach, being upstream from the significant inflows of Cook Creek and Chow-Chow Creek. From a practical viewpoint, this Reach supports less commercial fishing than QN2 simply because the shallower flows make access by boat more limited. However, it still provides excellent fish habitat, and has a wide 100-year floodplain, averaging between 5000 and 6000 feet across, but increasingly narrow upstream after each successive stream inflow is lost – Boulder Creek, Ten O'clock Creek, Prairie Creek and McCalla Creek.

The open flow section of the River in this reach is about 300 to 400 feet across, with about half of that width being broad gravel and sand bars in the main channel. This reach meanders many miles through relatively undeveloped forest lands, and includes forested uplands and

[34] Priority Habitats and Species Maps available in Quinault GIS system

freshwater forested wetlands within the 100-year floodplain, and many old logging roads extending onto the floodplain terrace.

Elevation at the River surface ranges from about 70 feet at the downstream end of the Reach, near the confluence with Cook Creek and Chow-Chow Creek, and 180 feet at the upstream end, a little more than a mile downstream from the U.S. Highway 101 Bridge at Amanda Park. The edge of the floodplain at the downstream end of QN3 is about 80 to 90 feet, and at the far upstream end of the Reach is about 200 feet elevation. The top of the upland forested terraces adjacent to the floodplain within the SAA at the west end are about 150 feet north of the River and about 280 feet south of the River. The upland terraces at the far east end are at about 340 feet elevation north of the River and about 220 feet south of the River.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands adjacent to the 100-year floodplain is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits) (Figure 45). Most of the Quinault River floodplain is mapped as more recent alluvium (Qa). Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till in the broad plains on both sides of the River. However, there is one small mapped area

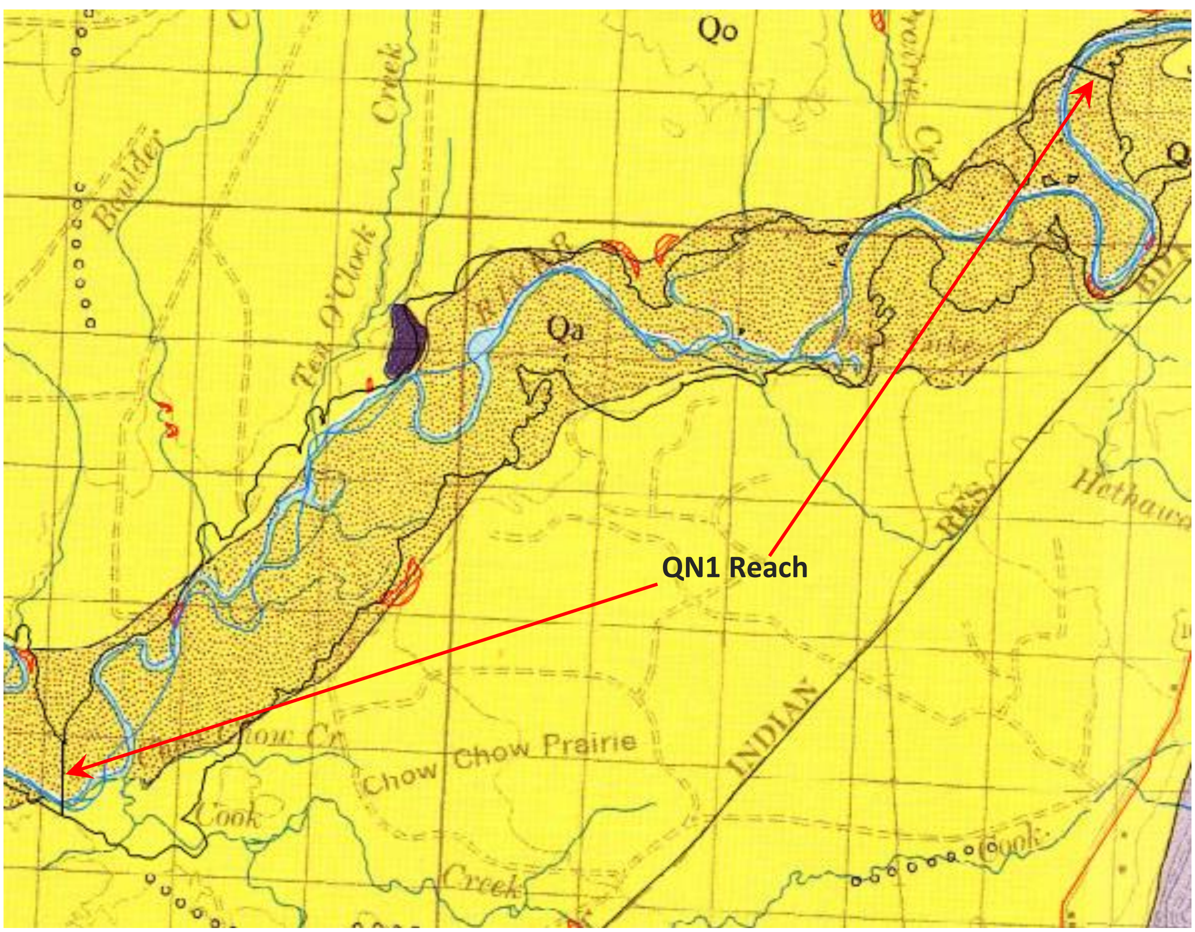


Figure 45. QN3 Geology Mapping

showing Tertiary age basalt (Tb – lava flows) north of this reach, indicating that basalt bedrock is likely to underlay the glacial till cap across most of the area.

The relatively impermeable glacial till, which is expected to dominate across on the terrace and upland surfaces near the River within the QN3 reach will restrict vertical movement of groundwater, resulting in seepage along river banks and terraces. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but they reflect Geology patterns discussed above. Many of the soils mapped in this Reach have sedimentary rock or a cemented till layer at 2 to 4 feet depth capped by outwash sediments (Aabab, Hoko, Papac, Matheny Creek), or glacial outwash substrate (Solduc, Southshore). The river floodplain and low terraces are mapped as recent alluvium (Chitwin, Donkey Creek, Hoh, Riverwash, Udifluvents), but the riverine floodplain also includes some areas of silty alluvium on terraces (Queets). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock, Chow-Chow).

Mapping indicates that most of the higher terrace surfaces outside of the river channel and floodplain are glacially influenced, with alluvium, loess or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. Underlying sedimentary bedrock is mapped only in one small area. At river bends, where soils are gradually eroded at toe slope by the river, the effect of horizontal drainage of groundwater and saturated soils at the top of the adjacent terrace is exacerbated, causing sluffing from erosion and larger mass-wasting failures that send huge sediment loads into the river. This problem is consistent along the outside of river bends throughout the Reservation, particularly in the larger rivers with higher winter flows.

Soils within the main river channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree. The lower terraces within the floodplain have older alluvium or lakebed sediments as a base, but are capped with more recent alluvium. Some of these areas closer to the River are mapped as wetlands, but some slightly higher elevation areas might flood periodically, but are not always wetland.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 19 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 19. Reach QN3 Soil Map Unit Descriptions					
Soil Map Unit	**Acres in Reach**	**Controlling Texture**	**Brief Soil Series Description**	**Depth to Seasonal Water**	**Depth to Impermeable Substrate**
1-Aabab medial silt loam	0.2	Medial silt loam	Formed in mixed sedimentary alluvium derived from sandstone and siltstone; On proglacial lakes	11"-28"; No ponding or flooding	>60"
5-Chitwhin medial silt loam	1687.37	Medial silt loam	Formed in silty alluvium; On low river terraces and floodplains	21"-30"; No ponding, Rare flooding (Jan-Mar and Dec)	>60"
7-Chowchow-Water complex	4660.86	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Oct-Dec) No flooding	22"-38" to a textural change
9-Donkeycreek medial loam	146.1	Medial silt loam	Formed in loamy alluvium over gravelly glacial outwash; On outwash plains	>72"; No ponding or flooding	14"-24" to stratification
15-Hoh medial fine sandy loam	2628.2	Medial silt loam	Formed in mixed alluvium; On low terraces and flood plains	>72"; No ponding, Brief occasional flooding (Jan-Mar and Dec)	40"-60" to stratification
17-Hoko very gravelly medial loam	14.7	Gravelly medial silt loam	Formed in glacial till derived from metasedimentary rock; On ground moraines	10"-15"; No ponding or flooding	22"-42" to cemented layer
22-**KYDAKA**-Copalisrock complex	32.8	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface; Long, frequent ponding (Jan-Mar and Dec) No flooding	25"-45" to dense material
22-Kydaka-**COPALISROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	At soil surface; Long, frequent ponding (Jan-May and Nov-Dec) No flooding	28"-38" to dense material
29-Mathenycreek medial silt loam	9.2	Medial silt loam	Formed in silty alluvium over glacial outwash; On till plains	19"-26"; No ponding or flooding	22"-42" to cemented layer
35-Mosesprairie peat	85.6	Peat	Formed in organic material over silty glaciolacustrine deposits; On proglacial lakes of till plains	At soil surface; Very long, frequent ponding (Jan-Jun and Nov-Dec) No flooding	50"-80" to textural change
42-Papac medial silt loam, 8-30%	145.8	Gravelly medial silt loam	Formed in alpine glacial till; On ground moraines	13"-28"; No ponding or flooding	21"-41" to dense material
43-Papac medial silt loam, 30-65%	104.3	Gravelly medial silt loam	Formed in weathered glacial drift; On glacial terraces and till plains	13"-28"; No ponding or flooding	21"-41" to dense material

45-Queets medial silt loam	192.3	Medial silt loam	Formed in silty alluvium; On terraces	>72"; No ponding or flooding	>60"
46-**RIVERWASH**-Water-Udifluvents complex	713.5	Sandy, gravelly	Unstabilized sandy and gravelly deposits that are reworked by streams and rivers; In river valleys	No ponding, Very long, frequent flooding (Jan-Jul and Oct-Dec)	Flooding
46-Riverwash-**WATER**-Udifluvents complex	Same as above	Surface water	Open bodies of water, such as the Quinault River	Surface water	Surface water
46-Riverwash-Water-**UDIFLUVENTS** complex	Same as above	Sandy, gravelly	Formed in alluvium; In flood plains	12"-24"; No ponding, Brief, frequent flooding (Jan-Apr and Nov-Dec)	>60"
52-Solduc very gravelly medial loam	28.3	Very gravelly medial sandy loam	Formed in glacial outwash; On glacial outwash plains or terraces and associated escarpments	>72"; No ponding or flooding	>60"
56-Southshore gravelly medial silt loam	5.9	Extremely gravelly medial silt loam	Formed in alpine glacial till; On outwash plains	41"-51"; No ponding or flooding	42"-62" to cemented layer

Gravel pits

At least 24 gravel pits are mapped near the edge of the QN3 SAA (Figure 46), but none are mapped as being inside of the SAA. The ones mapped nearby are mostly more than 500 feet from the edge of the SAA, although there are some areas within the SAA that appear to have been gravels pits, but were perhaps missed when the mapping was carried out. All gravel pits appear to be associated with logging, perhaps providing materials for building nearby roads.

Landslides

Seven landslides are mapped within or directly adjacent to this reach. Four of the seven were caused or exacerbated by a logging road or gravel pit excavation. The rest appear to have been caused by river meanders eating away a toe slope and destabilizing the slope above (Figure 46. Photos of the landslide areas are provided below. Some are no longer active, and have stabilized.

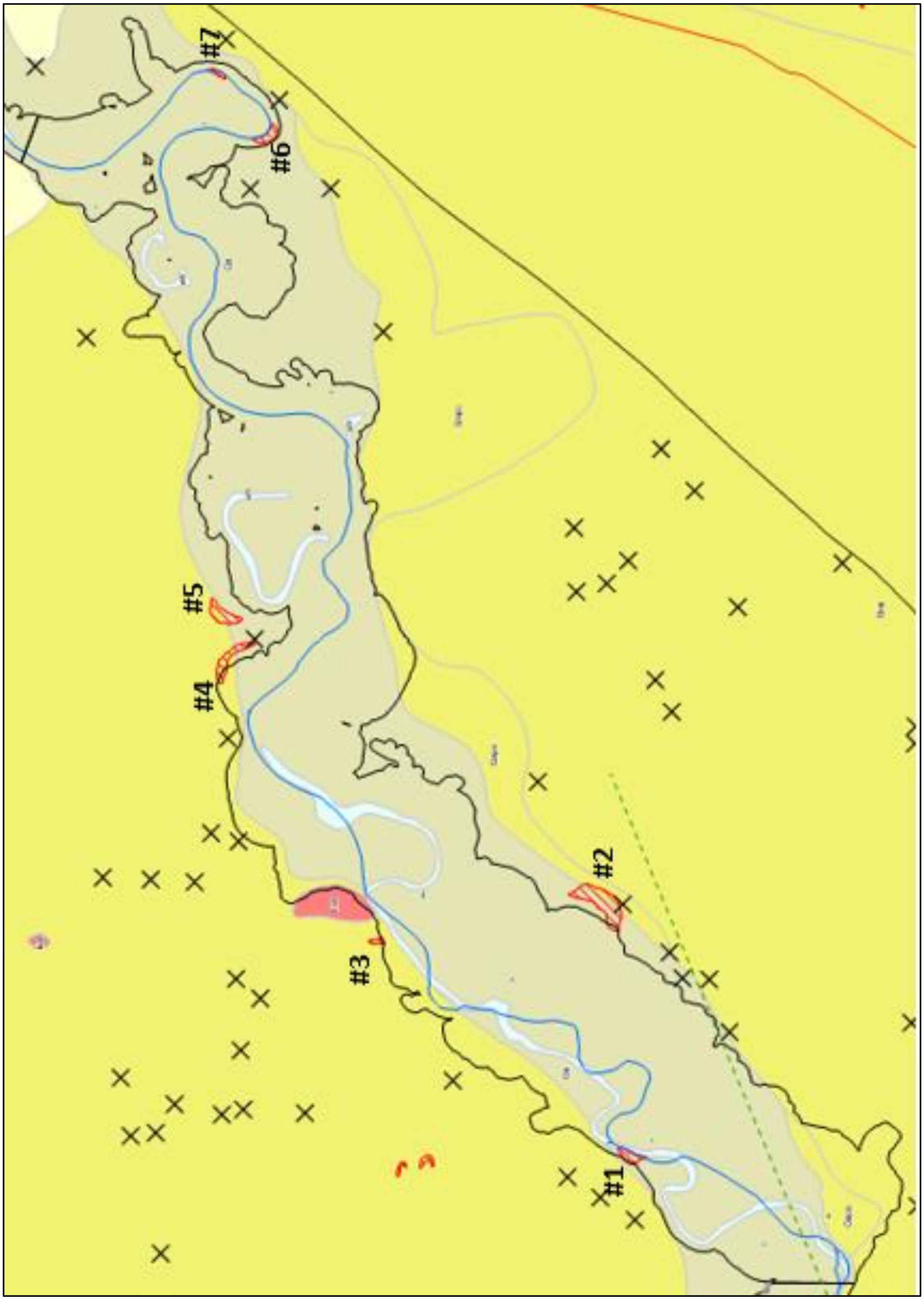


Figure 46. Landslides and gravel pits (X) mapped in and near QN3; landslides are numbered to reference photos to follow.

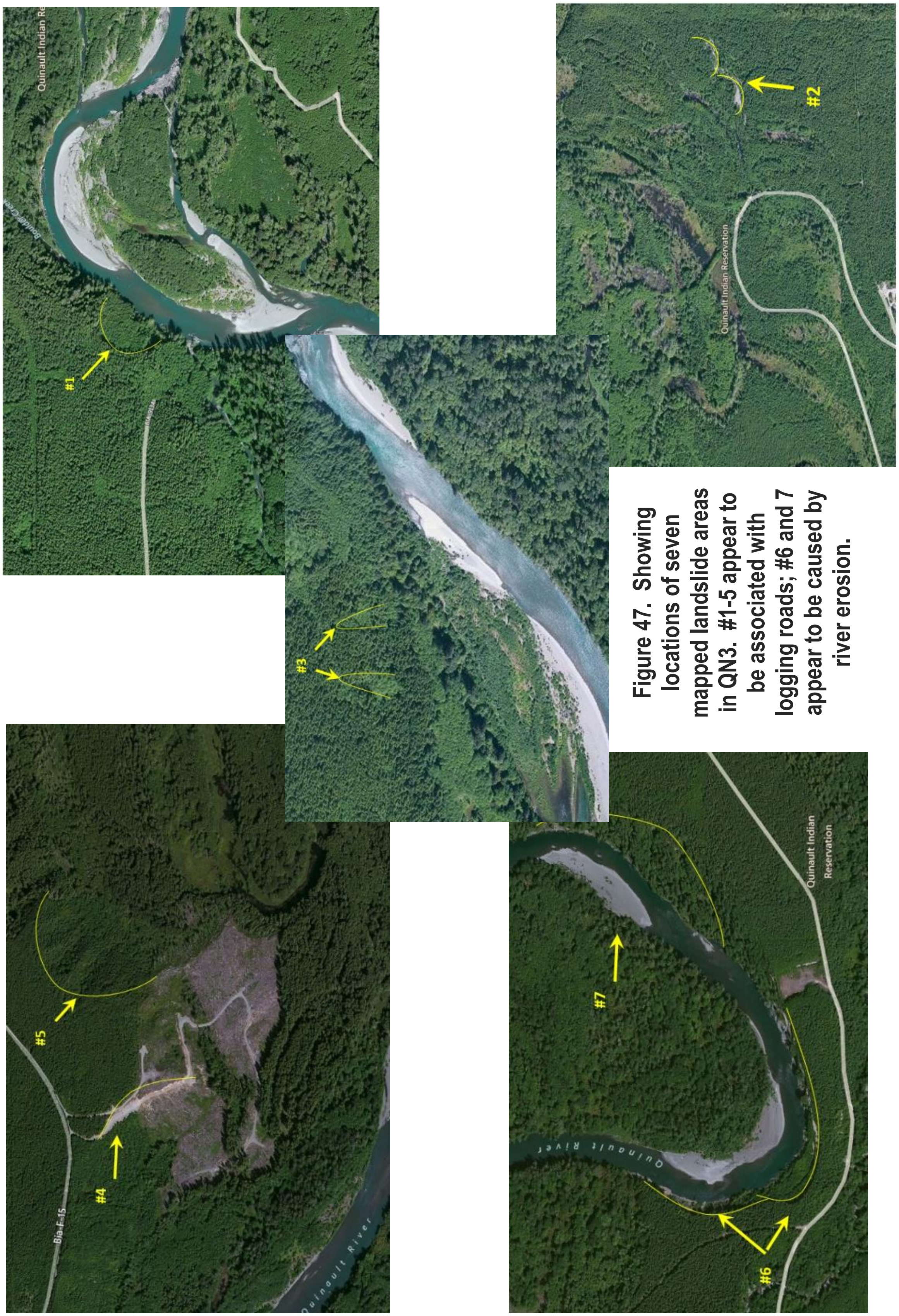


Figure 47. Showing locations of seven mapped landslide areas in QN3. #1-5 appear to be associated with logging roads; #6 and 7 appear to be caused by river erosion.

Tsunami

Tsunami impacts are not expected in QN3.

Critical Features

- Quinault River floodplain; critical salmonid habitat; floodplain more than a mile wide in some areas
- High bluffs adjacent to the River, which are susceptible to undercutting and failure under natural conditions at river bends; failure potential can be exacerbated by logging road impacts.
- Extensive high quality oxbow-island forested wetlands in river floodplain; highly active meander channel.

Critical Habitats and Species[35]

- Salmon (Quinault River): coho, chinook, steelhead, sockeye, bull trout, pink salmon, cutthroat, fall chum are listed (by WDFW) as being present in the Quinault River
- River floodplain, forested and shrub wetlands
- Ten bald eagle nests, randomly located along the Reach, with some clustering within River bends
- Spotted owl habitat mapped in the Township, which covers the eastern half of QN3.

Shoreline Access

Access for most of the QN3 Reach is from the well-developed BIA road network on both sides of the River, which extends into the floodplain to the River edge at several locations. This section may also be accessed by boat, but likely only during periods of high water.

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QN4: Quinault River, Reach 4 –Narrows near U.S. Highway 101 Bridge to edge of Lake Quinault (1.72 River Miles)

The Quinault River in Reach 4 (QN4) is the final reach for the Quinault River. It is narrower and more deeply incised than downstream reaches. This Reach forms the outlet from Lake Quinault, and flows below the U.S. Highway 101 Bridge, directly adjacent to developed areas

[35] Priority Habitats and Species Maps available in Quinault GIS system

around Amanda Park. This Reach is less than 2 miles long, and is adjacent to more developed areas than the middle Reaches – QN2 and QN3.

The open flow channel of the River in this Reach is about 350 feet across in the section between Lake Quinault and the U.S. Highway 101 Bridge. Downstream sections below the bridge are narrower – 150 to 250 feet wide, with minimal sand and gravel bars. The southeast side of the River is mostly relatively undeveloped forest lands, while the northwest side is developed commercial area, including a hotel, gas station, café and the potential for boat access to the Lake.

Elevation at the River surface ranges from about 180 feet at the downstream end of the Reach, a little more than a mile downstream from the U.S. Highway 101 Bridge at Amanda Park where the river channel narrows. At the upper end – the outlet of Lake Quinault – the water surface elevation is about 190 feet, giving that section of the River about a 1% gradient. The edge of the floodplain at the downstream end of QN4 is about 190 feet, and at the far upstream end of the Reach is about 200+ feet elevation. The top of the upland forested terraces adjacent to the floodplain within the SAA range between 340 feet elevation north of the River and about 220 feet south of the River at the downstream end and between 260 to 300 feet at the end near lake Quinault.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands adjacent to the 100-year floodplain is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits) (Figure 48). Most of the Quinault River floodplain is mapped as more recent alluvium (Qa). Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till in the broad terraces on both sides of the River. However, there are some small mapped areas showing Tertiary age conglomerates (Tsc – sedimentary rocks) nearby, indicating that sedimentary bedrock is likely to underlay the glacial till cap across most of the area.

The relatively impermeable glacial till, which is expected to dominate across on the terrace and upland surfaces near the River within the QN4 reach will restrict vertical movement of groundwater, resulting in seepage along river banks and terraces. Please refer to Digital Geology Map A-5 for details.

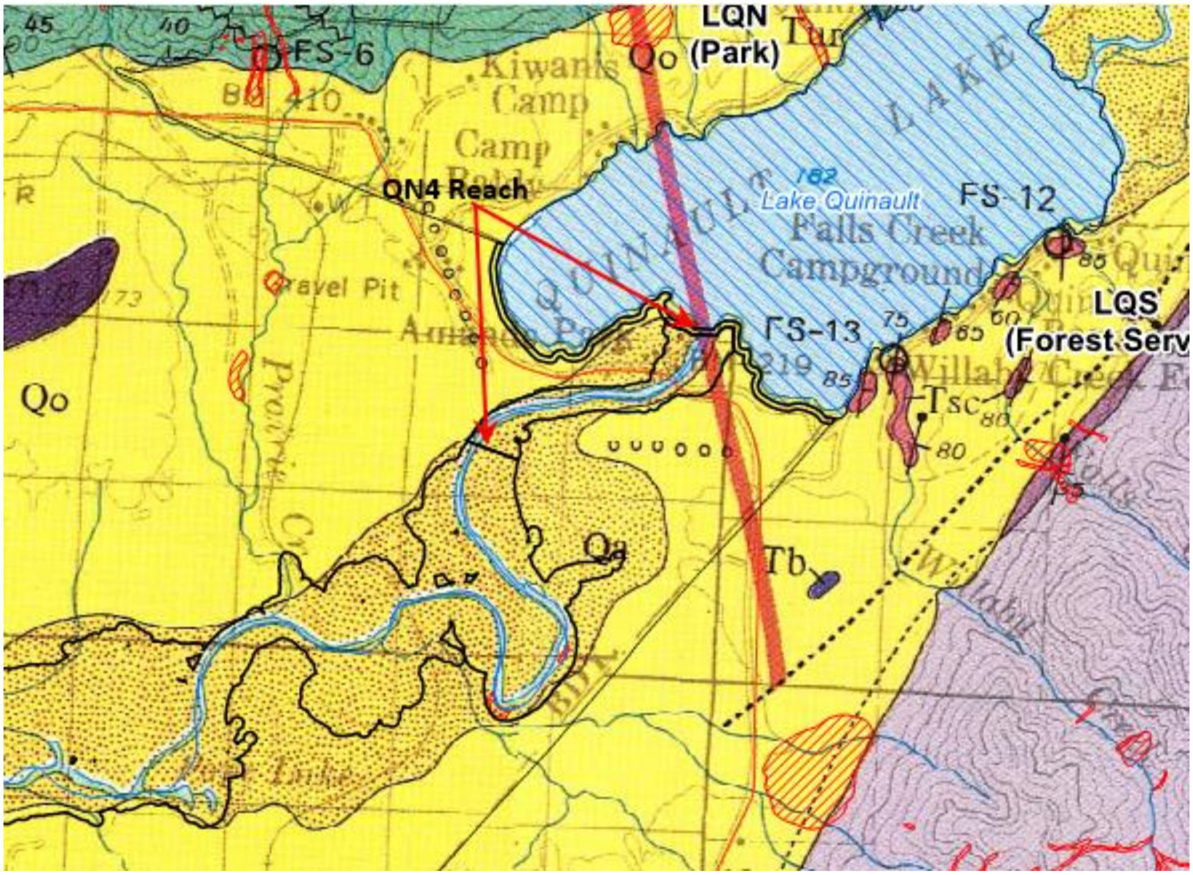

Figure 48. QN4 Geology Mapping

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach have sedimentary rock or a cemented till layer at 2 to 4 feet depth capped by outwash sediments (Mudcreek, Hoko, Papac). The river floodplain and low terraces are mapped as recent alluvium (Donkey Creek, Hoh, Riverwash, Udifluvents), but the riverine floodplain also includes some areas of silty alluvium on terraces (Kalaloch).

In this Reach, like other riverine reaches in the Reservation, mapping indicates that most of the higher terrace surfaces outside of the River channel and floodplain are glacially influenced, with alluvium, loess or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. Underlying metamorphosed sedimentary bedrock is mapped along the sides of the narrow section downstream of the bridge. The terraces surfaces are expected to have shallow cemented layers in many areas, which may result in seasonal perched water tables in the Amanda Park Area. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the riverine terrace faces, forming seeps.

Soils within the main river channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree. The lower terraces within the floodplain have older alluvium or lakebed sediments as a base, but are capped with more recent alluvium. Some of these areas closer to the River are mapped as wetlands, but some slightly higher elevation areas might flood periodically, but are not always wetland.

The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 20 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 20. Reach QN4 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
9-Donkeycreek medial loam	61.6	Medial silt loam	Formed in loamy alluvium over gravelly glacial outwash; On outwash plains	>72"; No ponding or flooding	14"-24" to strongly contrasting textural stratification
15-Hoh medial fine sandy loam	12.4	Medial silt loam	Formed in mixed alluvium; On low terraces and flood plains	>72"; No ponding, Brief occasional flooding (Jan-Mar and Dec)	40"-60" to strongly contrasting textural stratification
17-Hoko very gravelly medial loam	36.4	Gravelly medial silt loam	Formed in glacial till derived from metasedimentary rock; On ground moraines	10"-15"; No ponding or flooding	22"-42" to cemented layer; 27"-59" to dense material
36-Mudcreek gravelly medial loam	52.7	Gravelly medial loam	Formed in colluvium derived from alpine glacial till deposits; On ground moraines	20"-30"; No ponding or flooding	23"-43" to dense material
37-**MUDCREEK**-Kalaloch complex	24.1	Gravelly medial loam	Formed in colluvium derived from alpine glacial till deposits; On ground moraines	20"-30"; No ponding or flooding	23"-43" to dense material
37-Mudcreek-**KALALOCH** complex	Same as above	Medial loam	Formed in silty alluvium over glacial outwash; On ground moraines	>72"; No ponding or flooding	23"-43" to strongly contrasting textural stratification
43-Papac medial silt loam	10.4	Gravelly medial silt loam	Formed in weathered glacial drift; On glacial terraces and till plains	13"-28"; No ponding or flooding	21"-41" to dense material

46-**RIVERWASH**-Water-Udifluvents complex	34.1	Sandy, gravelly	Unstabilized sandy and gravelly deposits that are reworked by streams and rivers; In river valleys	No ponding, Very long, frequent flooding (Jan-Jul and Oct-Dec)	Flooding
46-Riverwash-**WATER**-Udifluvents complex	Same as above	Surface water	Open bodies of water, such as the Quinault River	Surface water	Surface water
46-Riverwash-Water-**UDIFLUVENTS** complex	Same as above	Sandy, gravelly	Formed in alluvium; In flood plains	12"-24"; No ponding, Brief, frequent flooding (Jan-Apr and Nov-Dec)	>60"

Gravel pits

Only two gravel pits are mapped nearby, one on either side of the River. But none are mapped as being inside of the SAA. The ones mapped nearby are both more than 1,500 feet from the SAA boundary. Both appear to be associated with past logging, perhaps providing materials for building nearby roads.

Landslides

No landslides are mapped within or directly adjacent to this reach.

Tsunami

Tsunami impacts are not expected in QN3.

Critical Features

- Quinault River floodplain; critical salmonid habitat; outlet of Lake Quinault
- Amanda Park and associated infrastructure west of the River
- U.S. Highway 101 Bridge crossing, the only Highway connection to points north
- Septic systems around Amanda Park
- Residences along the western shoreline

Critical Habitats and Species[36]

- Salmon (Quinault River): coho, chinook, steelhead, sockeye, bull trout, pink salmon, cutthroat, fall chum are listed (by WDFW) as being present in the Quinault River

[36] Priority Habitats and Species Maps available in Quinault GIS system

- River floodplain, forested and shrub wetlands
- Two bald eagle nests along the River downstream from the bridge
- Spotted owl habitat mapped in the Township, which covers the whole SAA and areas to the northwest

Shoreline Access

Access for the southern portion of the QN4 Reach is from the well-developed BIA road network on both sides of the River, although there is no apparent road access to the narrow section with an incised floodplain. Access to the areas west of the River around Amanda Park is possible along the roadways, and by foot. However, even though there is a boat ramp at Amanda Park, only Tribal members are allowed access to the River, and by extension, to the Lake from Amanda Park.

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4.3.7 Wreck Creek Reach

Wreck Creek is an important system along the southern coast, because it flows under State Route 109 at a particularly vulnerable, low elevation section of road south of Point Haynisisoos (Figure 49). For that reason, it is important in managing and protecting that critical stretch of highway – the primary connector between Taholah and points south.

Wreck Creek has only one Reach, starting at the U.S. Highway 101 Bridge and extending upstream 0.69 miles, to where North Fork of Wreck Creek and Baker Creek tributaries merge with the main channel.

WC1: Wreck Creek, Reach 1 – State Route 109 Bridge upstream to confluence with the North Fork Wreck and Baker Creek (0.69 River Miles)

The Wreck Creek Reach (WC1) is the only reach for the system, being less than a mile long. It is not a large D-River, but is very important due to the vulnerable State Route 109 Bridge crossing. The Creek flows under the bridge and directly onto the Beach in Coastal Reach C1.

The open flow channel of the Creek near the State Route 109 Bridge is 70 to140 feet wide, including sand and gravel bars. Upstream sections are narrower and incised, barely visible below the trees on both sides of the channel.

Elevation at the water surface ranges from less than 10 feet at the bridge up to 80 feet at the upper end of the Reach, a gradient of almost 2%. The Wreck Creek Floodplain is about 400 feet wide in the lower sections of the Reach. The upland slopes and terraces beside the creek adjacent to the floodplain are about 100 to 120 feet elevation.

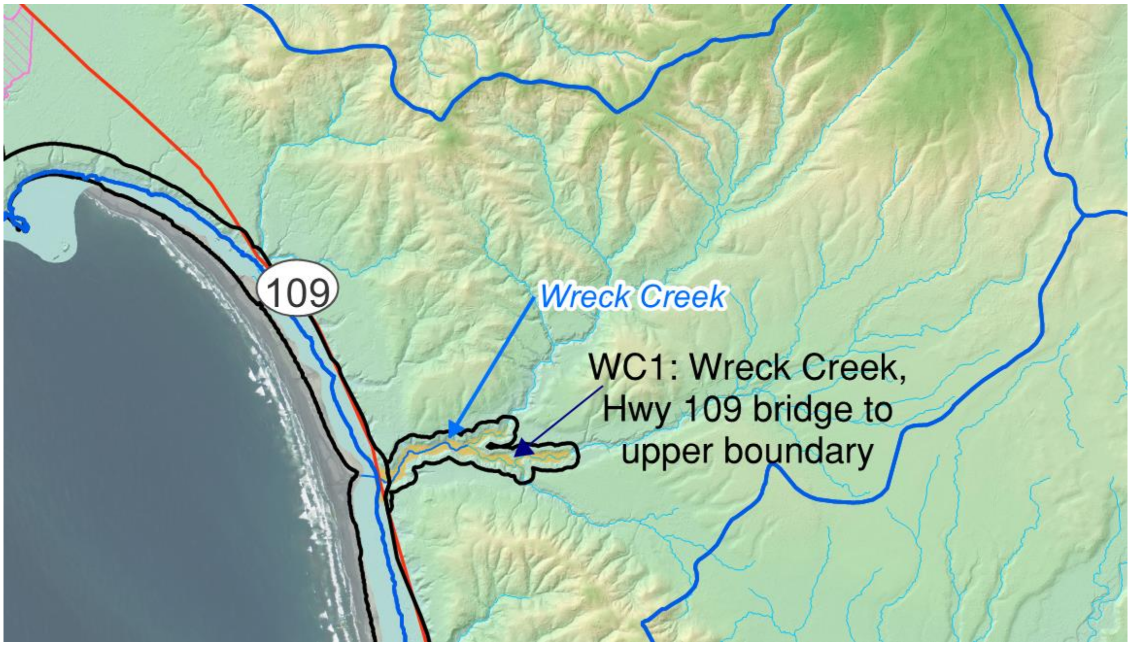

Figure 49. Wreck Creek Reach, WC1.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands adjacent to the 100-year floodplain is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits) (Figure 50). The Wreck Creek floodplain can be assumed to be composed of recent alluvium (Qa). Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till in the broad terraces on both sides of the River. However, there is a large Tertiary age sandstone, siltstone, and/or undifferentiated conglomerate outcrop (Thsu map

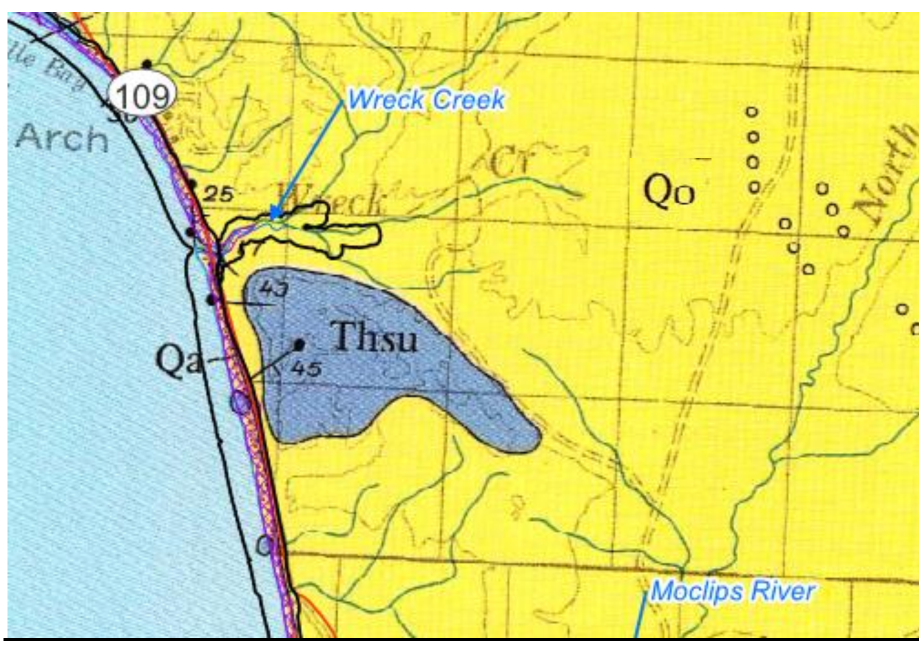

Figure 50. Wreck Creek Reach Geology Map

unit) to the southeast, which indicates that bedrock is likely to underlay the glacial till cap across most of the area.

The relatively impermeable glacial till, which is expected to dominate across on the terrace and upland surfaces near the Creek within the WC1 reach will restrict vertical movement of groundwater, resulting in seepage along banks and side slopes. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but they reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 3 to 4 feet depth capped by outwash sediments (Papac), or glacial outwash substrate (Calawah). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Kydaka, Copalis Rock). Some of the coastal estuary area is mapped as having well-drained sandy sediments (Westport, and Dune Land).

In this reach, like other riverine reaches in the Reservation, mapping indicates that most of the higher terrace surfaces outside of the river channel and floodplain are glacially influenced, with alluvium, loess or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the riverine terrace faces, forming seeps.

Soils within the main creek channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree. The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 21 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 21. Reach WC1 Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
3-Calawah medial silt loam	8.9	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	>72"; No ponding or flooding	>60"
22-**KYDAKA**-Copalisrock complex	34.7	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface; Long, frequent ponding (Jan-Mar and Dec) No flooding	25"-45" to dense material

22-Kydaka-**COPALISROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	At soil surface; Long, frequent ponding (Jan-May and Nov-Dec) No flooding	28"-38" to dense material
42-Papac medial silt loam, 8-30%	11.0	Gravelly medial silt loam	Formed in alpine glacial till; On ground moraines	13"-28"; No ponding or flooding	21"-41" to dense material
43-Papac medial silt loam, 30-65%	52.6	Gravelly medial silt loam	Formed in weathered glacial drift; On glacial terraces and till plains	13"-28"; No ponding or flooding	21"-41" to dense material
61-**WESTPORT** and Dune land soils	0.4	Fine sand	Formed in eolian sand; On dunes	>72"; No ponding or flooding	>60"
61-Westport and **DUNE LAND** soils	Same as above	Fine sand	Formed in eolian sand; On dunes	No ponding or flooding	>60"

Gravel pits

Only one gravel pit is mapped nearby, on the south side of the Creek, about 900 feet south of the edge of the SAA. The gravel pit is still active, and is associated with current logging activities.

Landslides

No landslides are mapped within or directly adjacent to this reach.

Tsunami

WaDNR 2010 tsunami models provide detailed map information for the area near Wreck Creek. There are two different modeled map outcomes for tsunami impacts along the southern Reservation Shoreline (described previously in Section 3.3). These models indicate the potential for severe inundation across the beach with wave and over-wash impacts of 20 to 30 feet elevation, which would wash over the bridge and highway and extend about 1,500 feet upstream in Wreck Creek. Even a minor tsunami event would be likely damage or destroy the State Route 109 Bridge and sections of the highway, cutting off Taholah from points south.

Critical Features

- State Route 109 Bridge crossing at Wreck Creek and associated vulnerable highway sections in the SAA, the only highway connection between Taholah and points south.

Critical Habitats and Species[37]

- River floodplain, forested and shrub wetlands
- One bald eagle nest mapped just outside of the SAA to the south.

Shoreline Access

Access to the Wreck Creek Reach is from the State Route 109 Bridge. Access to most of the SAA upslope would only be possible from logging roads or by foot. Beach access is not allowed by non-tribal members, unless they are accompanied by a Tribal representative.

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4.3.8 Moclips Reach

The Moclips River mouth and estuary are just outside of the southern Reservation boundary. But a small section of the Moclips that is within the Reservation is a Designated River, and therefore is included in the report.

The Moclips River has only one Reach, starting at the southern Reservation boundary and extending upstream 1.04 miles to the confluence with the North Fork Moclips Tributary (the end of the D-River section) (Figure 51).

M1: Moclips River, Reach 1 – southern Reservation boundary to North Fork Moclips (1.04 River Miles)

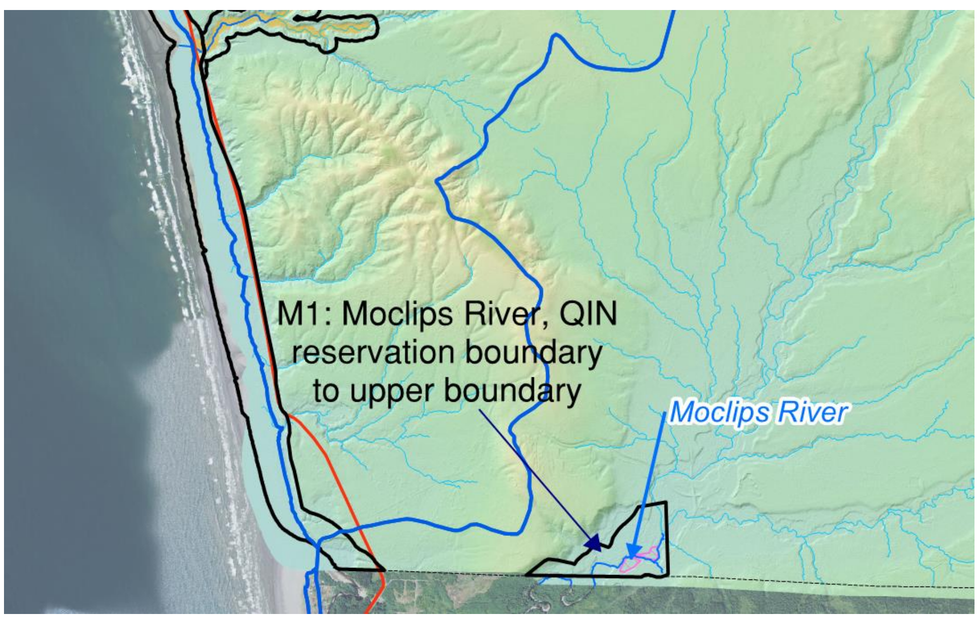

Figure 51. Moclips River Reach, M1.

The Moclips River Reach (M1) is the only Reach for the Moclips system and is only about 1 mile long. This Reach defines is a small section of the River that lies within the Reservation, but is still large enough to be regulated as a D-River. The Moclips estuary is

[37] Priority Habitats and Species Maps available in Quinault GIS system

outside of the Reservation to the south.

The open flow channel of the River in this section is 60 to 100 feet wide, including sand and gravel bars, but the floodplain is as wide as 2000 feet. Elevation at the water surface at the southern Reservation boundary – the downstream end of the Reach – is 40 feet; at the upper end – 50 feet. The upland slopes and terraces beside the River adjacent to the floodplain are about 100 to 120 feet elevation.

Geology Mapping

Like most of the Reservation, the surficial geology across the uplands adjacent to the 100-year floodplain is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits). The Moclips River floodplain can be assumed to be composed of recent alluvium (Qa). Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till on both sides of the River.

The relatively impermeable glacial till, which is expected to dominate across on the terrace and upland surfaces near the M1 Reach will restrict vertical movement of groundwater, resulting in seepage along banks and side slopes. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach have a cemented till layer at 3 to 4 feet depth capped by outwash sediments (Papac), or glacial outwash substrate (Calawah). The river floodplain and low terraces are mapped as recent alluvium (Hoh). Some areas have impermeable substrate with seasonally saturated surface soils with high organic matter content (Halbert, Joe Creek, Kydaka, Copalis Rock).

In this reach, like other riverine reaches in the Reservation, mapping indicates that most of the higher terrace surfaces outside of the river channel and floodplain are glacially influenced, with alluvium, loess or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the riverine terrace faces, forming seeps, which have potential to destabilize slopes.

Soils within the main creek channel are mostly recent deposits of gravelly and sandy alluvium, reworked almost every year to some degree. The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 22 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details).

Table 22. Reach M1 Soil Map Unit Descriptions					
Soil Map Unit	**Acres in Reach**	**Controlling Texture**	**Brief Soil Series Description**	**Depth to Seasonal Water**	**Depth to Impermeable Substrate**
3-Calawah medial silt loam	7.7	Medial silt loam	Formed in loess over gravelly glacial outwash; On outwash terraces	>72"; No ponding or flooding	>60"
14-Halbert peat	8.0	Muck	Formed in silty glaciolacustrine deposits over glacial outwash; On depressions of till plains	At soil surface; Long, frequent ponding (Jan-May and Oct-Dec) No flooding	28"-36" to placic horizon
15-Hoh medial fine sandy loam	65.2	Medial silt loam	Formed in mixed alluvium; On low terraces and flood plains	>72"; No ponding, Brief occasional flooding (Jan-Mar and Dec)	40"-60" to strongly contrasting textural stratification
19-Joecreek mucky silt loam	2.5	Mucky silt loam	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; On outwash terraces	At soil surface; Long, frequent ponding (Jan-May and Nov-Dec) No flooding	17"-25" to cemented layer; 21"-33" to dense material
23-**KYDAKA**-Copalisrock complex	5.4	Mucky silty clay loam	Formed in glacial lacustrine sediments over glacial outwash; On glacial outwash terraces	At soil surface; Long, frequent ponding (Jan-Mar and Dec) No flooding	25"-45" to dense material
23-Kydaka-**COPALISROCK** complex	Same as above	Peat	Formed in silty glaciolacustrine deposits over gravelly glacial outwash; on glacial outwash terraces on till plains	At soil surface; Long, frequent ponding (Jan-May and Nov-Dec) No flooding	28"-38" to dense material
43-Papac medial silt loam	5.1	Gravelly medial silt loam	Formed in weathered glacial drift; On glacial terraces and till plains	13"-28"; No ponding or flooding	21"-41" to dense material

Gravel pits

Only one gravel pit is mapped nearby, upslope and to the east of the end of the Reach. The gravel pit appears to still be active and associated with logging and related forest practice activities.

Landslides

No landslides are mapped within or directly adjacent to this reach.

Tsunami

WaDNR 2010 tsunami models provide detailed map information along the southern Washington coast up to just north of Cape Elizabeth on the Reservation. The two different modeled map outcomes for tsunami impacts along the southern Reservation Shoreline indicate the potential for inundation in the floodplain from wave and over-wash impacts up to 20 to 30 feet elevation. The waves would wash over the bridge and highway at Moclips, which is outside of the Reservation, but still an impact to Tribal transportation. No tsunami impacts are expected far enough upstream to impact Reach M1 on the Reservation.

However, even a minor tsunami event would be likely damage or destroy the State Route 109 Bridge and sections of the highway, cutting off Taholah and Moclips from points south.

Critical Features

- Although not on the Reservation, the State Route 109 Bridge crossing and associated highway sections in Moclips.

Critical Habitats and Species[38]

- River floodplain, forested and shrub wetlands
- Salmon (Moclips River): coho, steelhead, bull trout are listed (by WDFW) as being present in the Moclips River

Shoreline Access

Access to the Moclips Reach SAA is only possible from nearby logging roads, or by foot.

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4.4 Lake Reach Descriptions

4.4.1 Lake Quinault Reaches

Lake Quinault's Ordinary High Water Mark (OHWM) boundary forms the northeastern boundary of the Reservation, but only the shoreline landward of the water at the far southwest end of the Lake is within the Reservation. The rest of the uplands surrounding the northern, eastern and southern Lake boundary are not within the Reservation. Most of that land is either in the Olympic National Park or in the Olympic National Forest; some is privately owned.

[38] Priority Habitats and Species Maps available in Quinault GIS system

However, the QIN owns and manages the Lake, and thus will regulate activities that impact the Lake's functions and values. The Lake perimeter is split into three reaches (Figure 52).

The LQN Reach runs along the northern shoreline, starting at the Reservation boundary southeast of the intersection of North Shore Road and U.S. Highway 101, and extending northeast along the shore to where the Quinault River enters at the northeast end of the Lake. The northern shoreline includes many private property lots with single-family homes right along the edge of the water. Most are vacation homes, but some are permanent residences. However, the great majority of the land along the North Shore and upslope is in the Olympic National Park.

The LQS Reach runs along the southern shoreline, starting at the Reservation boundary, near the intersection of Old State 9 Road and South Shore Road. From there, LQS extends northeast along the southern shore to where the Quinault River enters at the northeast end of the Lake. The southern shoreline includes many small cabins built on leased Olympic National Forest Land. Lake Quinault Lodge, located about midway along the southern shoreline is privately owned, but is built on leased National Forest land. The land along the South Shore is in the Olympic National Forest. Parcels at the far northeast edge of the Lake are mostly privately owned, and most are managed as forest or in agriculture; some are managed as cabin resorts.

The LQW Reach is the southwestern Shoreline with land inside of the Reservation. It extends between the southwestern ends of LQN and LQS. This area includes Amanda Park and

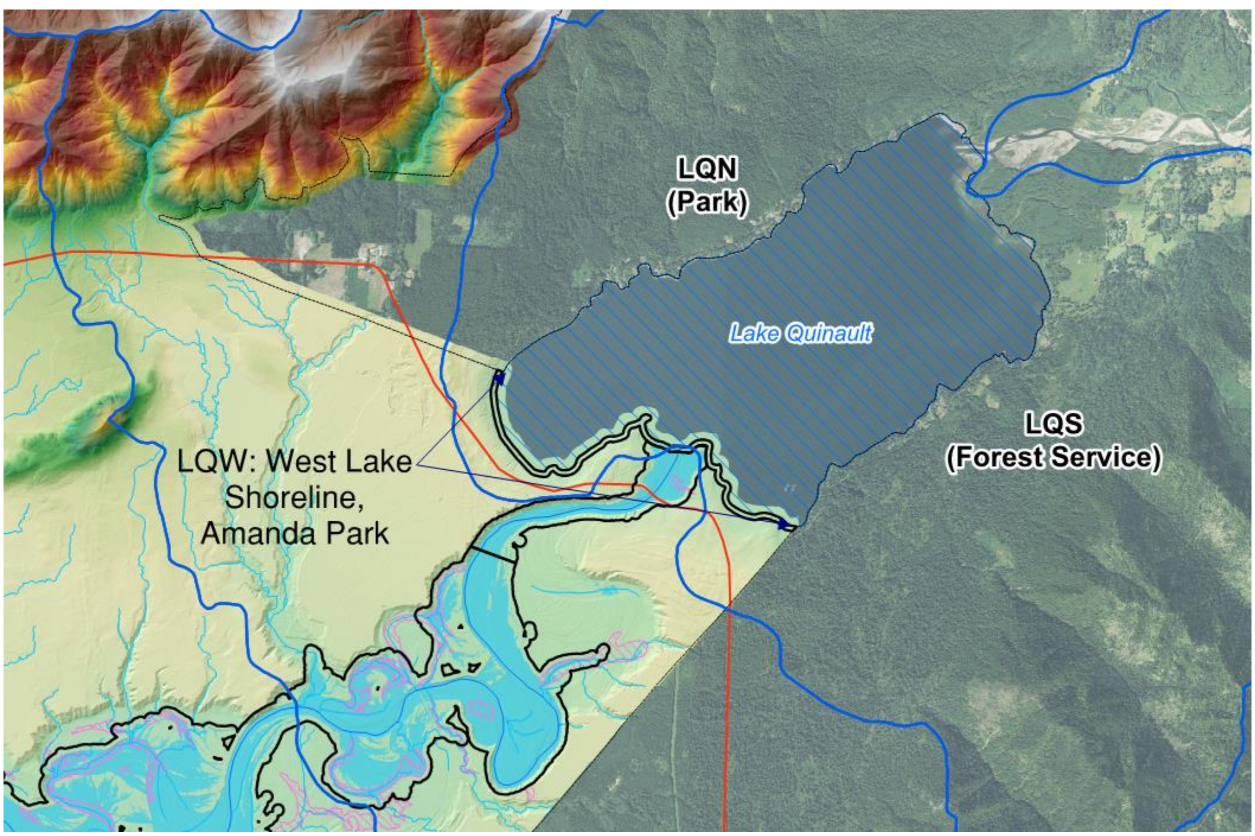

Figure 52. Lake Quinault Shoreline Reaches, LQN, LQS and LQW

associated urban, commercial, industrial and governmental land uses. It also includes many fee-owned parcels in and near Amanda Park.

LQW: Lake Quinault – Southwest Shoreline within the Reservation, Amanda Park area (2.63 Shoreline Miles)

The southwestern Lake Quinault Reach (LQW) is the only portion of the Lake Quinault Shoreline where the Reservation includes land surfaces outside of the water's edge. This Reach forms the southwestern shoreline of the Lake near Amanda Park. This Reach is less than 3 miles long, and includes a highly-developed section of the Lake Shoreline.

Elevation at the Lake surface varies significantly throughout the year, but is generally reported to range between 180 and 190 feet. The developed and forested upland terraces adjacent to the Lake within the SAA range between 260 and 300 feet elevation.

<u>Geology Mapping</u>

Like most of the Reservation, the surficial geology across the uplands adjacent to the Lake is mapped as glacial outwash (Qo, permeable sand and gravel flood deposits) and more recent alluvium (Qa) in the Quinault River floodplain (Figure 53). Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till in the broad terraces on both sides of the River. However, there are some small mapped areas near the SE corner of the

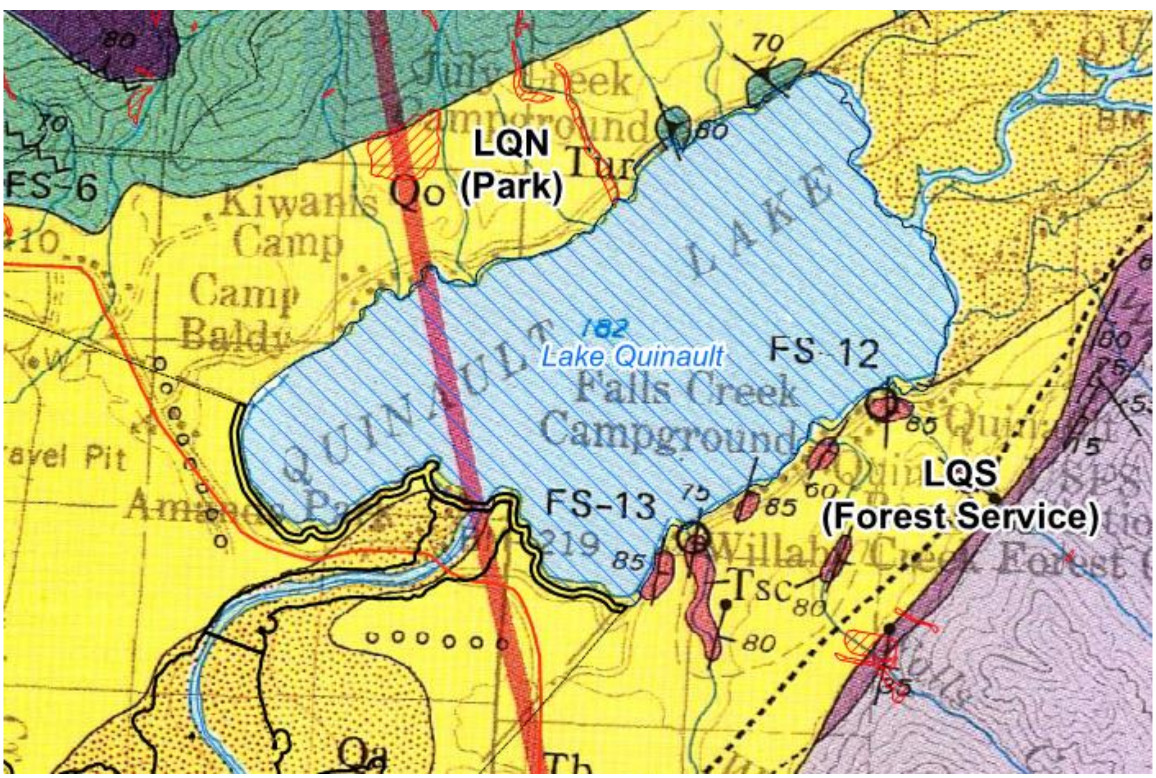

Figure 53. Lake Quinault Geology Map

Lake showing Tertiary age conglomerates (Tsc – sedimentary rocks), and some area along the northern shoreline mapped as undifferentiated Tertiary rocks – sandstone dominant with less than 40% siltstone and argillite, and some fossil-bearing layers (Tur map unit). These map units indicate that sedimentary bedrock is likely to underlay the glacial till cap across most of the area.

The relatively impermeable glacial till, which is expected to dominate across on the terrace and upland surfaces near the River within the LQW reach will restrict vertical movement of groundwater, resulting in seepage along lake banks and terraces. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps only describe the upper few feet of the surface, but soil maps along this reach reflect Geology patterns discussed above. Many of the soils mapped in this Reach are formed in colluvium derived from alpine glacial till deposits, often with cemented layers at 2 to 3 feet depth capped by outwash sediments (Mudcreek), or silty alluvium over glacial outwash substrate (Kalaloch). The river floodplain and low terraces are mapped as recent alluvium (Donkey Creek).

Because the Shoreline Area only extends 200 feet from the Lake edge, soil mapping is very limited, but indicates that most of the higher terrace surfaces outside of the Lake are glacially influenced, with alluvium, loess or glacial lakebed surface deposits overlying relatively impermeable cemented till layers at 2 to 4 feet depth. The terraces surfaces are expected to have shallow cemented layers in many areas, which may result in seasonal perched water tables in the Amanda Park Area. These impermeable substrates perch seasonal stormwater, causing subsurface water to drain horizontally, often surfacing along the Lake terrace faces, forming seeps.

Soils around the Lake perimeter are dominated by moraine-type parent materials, and thus are complex and layered, but generally coarse-textured. The soils mapped along the Reach are only described within the limits of the SAA for this report, but it is recommended to consult the greater soil map of the surrounding area to provide context with other soils mapped outside of the SAA that may interact or inform of adjacent conditions.

Table 23 lists soils mapped in this reach. (Please refer to Digital Soil Survey Map A-8 for soil map unit details)

Table 23. Reach LQW Soil Map Unit Descriptions

Soil Map Unit	Acres in Reach	Controlling Texture	Brief Soil Series Description	Depth to Seasonal Water	Depth to Impermeable Substrate
9-Donkeycreek medial loam	14.3	Medial silt loam	Formed in loamy alluvium over gravelly glacial outwash; On outwash plains	>72"; No ponding or flooding	14"-24" to strongly contrasting

					textural stratification
36-Mudcreek gravelly medial loam	10.8	Gravelly medial loam	Formed in colluvium derived from alpine glacial till deposits; On ground moraines	20"-30"; No ponding or flooding	23"-43" to dense material
37-**MUDCREEK**-Kalaloch complex	52.9	Gravelly medial loam	Formed in colluvium derived from alpine glacial till deposits; On ground moraines	20"-30"; No ponding or flooding	23"-43" to dense material
37-Mudcreek-**KALALOCH** complex	Same as above	Medial loam	Formed in silty alluvium over glacial outwash; On ground moraines	>72"; No ponding or flooding	23"-43" to strongly contrasting textural stratification
60- Water	5.6	water	Surface water	Surface water	Surface water

Gravel pits

There is a large gravel pit complex mapped about ½ mile west of the northern end of LQW, west of the highway, well outside of the SAA.

Landslides

No landslides are mapped within or directly adjacent to this reach.

Tsunami

Tsunami impacts are not expected in LQW.

Critical Features

- Lake Quinault Shoreline; critical salmonid habitat; outlet of Lake Quinault
- Amanda Park and associated infrastructure west of the River
- Septic systems around Amanda Park and other nearby development areas
- Residences along the shoreline

Critical Habitats and Species[39]

- Salmon (Quinault River): coho, chinook, steelhead, sockeye, bull trout, pink salmon, cutthroat, fall chum are listed (by WDFW) as being present in Lake Quinault
- River floodplain, forested and shrub wetlands at Lake edge
- Spotted owl habitat mapped in the Township, which covers most of the Lake to the north

[39] Priority Habitats and Species Maps available in Quinault GIS system

Shoreline Access

Access to the residences along the Shoreline west of the River is from small side roads extending from Amanda Park. Access to the Shoreline east of the River is from a section of the old Highway – "Old Washington-9" – which can be accessed from the main South Shore Road or from old local logging roads.

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LQS and LQN: Lake Quinault – Southern and Northern Shoreline extending to northeast inflow of Quinault River

LQS and LQN do not include any land-surfaces within the Reservation, but the QIN owns and manages the Lake. These reaches start at the western and eastern end of LQW and extend up the south and north shore all the way to the eastern inflow of Quinault River at the north end of the Lake.

Elevation at the Lake surface varies significantly throughout the year, but is generally reported to range between 180 and 190 feet.

Geology Mapping

The surficial geology across the uplands along the shoreline adjacent to the Lake is mapped as glacial drift – which is a combination of glacial till and glacial outwash – basically a generic glacial deposit (Figure 53, previous section). Substrate below the outwash surface in this area is assumed to be dominated by semi-cemented glacial till in the broad terraces on both sides of the River. However, there are several areas mapped as outcrops of marine sedimentary rock (OEm), indicating that sedimentary bedrock is likely to underlay the glacial cap across most of the area.

The relatively impermeable glacial till, which is expected to dominate across on the upland surfaces near the Lake will restrict vertical movement of groundwater, resulting in seepage along banks and terraces. Please refer to Digital Geology Map A-5 for details.

Soils Mapping

Soil Survey maps along the southern shoreline is very general – only described as a Mudcreek-Kalaloch Complex (colluvium derived from alpine glacial till deposits, capped by outwash sediments and silty alluvium over glacial outwash substrate). No soil mapping is available for the North shoreline, but in general is expected to be similar to the southern shoreline, and will include some shallow to bedrock soil types. Soil mapping is very limited, but indicates that most of the higher terrace surfaces outside of the Lake are glacially influenced.

Soils around the Lake perimeter are dominated by moraine-type parent materials, and thus are complex and layered, but generally coarse-textured.

Table 24 lists the very generalized soils mapped in this reach.

Table 24. Reach LQS and LQN				
Soil Map Unit	**Controlling Texture**	**Brief Soil Series Description**	**Depth to Seasonal Water**	**Depth to Impermeable Substrate**
37-**MUDCREEK**-Kalaloch complex	Gravelly medial loam	Formed in colluvium derived from alpine glacial till deposits; On ground moraines	20"-30"; No ponding or flooding	23"-43" to dense material
37-Mudcreek-**KALALOCH** complex	Medial loam	Formed in silty alluvium over glacial outwash; On ground moraines	>72"; No ponding or flooding	23"-43" to stratification

Gravel pits

No information about gravel pits is available for this area.

Landslides

No information about Landslides is available for this area.

Tsunami

Tsunami impacts are not expected in LQS or LQN.

Critical Features

- Lake Quinault Shoreline; critical salmonid habitat
- Septic systems and residences along the shoreline
- Lake Quinault Lodge and associated infrastructure
- Docks and other lake surface structures along the Shoreline

Critical Habitats and Species[40]

- Salmon (Quinault River): coho, chinook, steelhead, sockeye, bull trout, pink salmon, cutthroat, fall chum are listed (by WDFW) as being present in Lake Quinault
- Forested and shrub wetlands at Lake edge
- Spotted owl habitat mapped in the Township, which covers most of the Lake to the north

Shoreline Access

Access to the Shoreline is mostly controlled by from private lots, but is available from several resorts and camps which provide direct access for the public.

[40] Priority Habitats and Species Maps available in Quinault GIS system

5. SHORELINE USE ANALYSIS

5.1 APPROACH

The purpose of Chapter 5 is to summarize and analyze current and future shoreline uses within each Reach. An examination of existing and current land uses, associated regulations, and ownership statistics provides a baseline for the types and patterns of land uses within the Reservation's SAAs that may be anticipated in future years. The QIN zoning data and land use data from Washington Department of Ecology (2010) were used to obtain information about current land uses within the SAA.

5.1.1 Current Land Uses

Title 48 (Land Use and Development Code) is the QIN law governing zoning and its administration/enforcement. The QIN classifies lands on the Quinault Reservation into five zoning categories: Residential, Commercial, Industrial, Forestry, and Wilderness. Within each zone, separate standards and regulations apply that affect the types of land uses that can occur in these areas. All Reservation land is accessible to QIN members and guests, or by permit.

According to QIN GIS data, 84 percent of land within the total SAA (all reaches combined) is zoned as Forestry, 13 percent is zoned as Wilderness, 1 percent is zoned as Residential, and less than 1 percent is zoned as Commercial. The following general land uses are common within these zoning categories, arranged by their proportion of the SAA:

Forestry zones are typically used for commercial forestry uses. However, some lands are maintained as riparian reserves to protect major drainages. These riparian reserves are also used for hunting, fishing, and camping by QIN members and invited guests. Transportation infrastructure and gravel extraction pits are relatively common within SAA lands zoned as Forestry. The Salmon Creek fish hatchery is another use located within the forest zone. Minor portions of lands zoned for Forestry are also used for low density residential purposes, particularly along the west end of Lake Quinault and areas around Taholah and Queets.

In general, the Wilderness designation applies to forest lands along the coastline that are kept in conservation status to protect ecological functions, provide low intensity recreation opportunities, maintain important wildlife habitat, and stabilize coastal bluffs that are especially susceptible to coastal erosion. Typical land uses within this zone include coastal recreation, including beach combing and sites of cultural significance. Tribal fishing is common in this zone near the mouths of the Quinault and Queets Rivers. Non-tribal residential inholdings are common in the Wilderness Zone along State Route 109. The mouth of the Queets River is zoned as Wilderness.

The Residential and Commercial Zones represent a small portion of the SAA but they are the portions most frequented by humans. These zones include major portions of Taholah, Queets, and Amanda Park within the SAA. Within the shoreline areas, land uses in the Residential Zone include fishing, stormwater management, flood hazard management, tourism, commercial fishery facilities, and transportation uses, in addition to typical residential uses and small commercial businesses. No lands zoned as Industrial are located within the SAA.

5.1.2 Current Land Use Management

Based on the QIN Land Use and Development Code the following descriptions apply to the five recognized zoning categories:

- Residential Zone – No uses and structures permitted, unless for residential purposes or accessory to a residential use, which includes mixed uses of civic and public uses and home based businesses. Schools, churches, cemeteries, public buildings and their land uses, apartment houses, and other multiple dwellings are classified as residential. Small shops are conditional use in this zone.
- Commercial Zone – An open commercial zone for commercial light industrial activities, from gas stations to supermarkets to warehousing, home-based businesses, and light manufacturing.
- Industrial Zone – An exclusive zone for industrial activities that have limited noxious emissions in fumes, particulate matter, waste water, noise, or vibrations. Examples of land uses appropriate to this zone are light manufacturing involving shake mills, the assembly of small machined parts, research activities, and warehousing. Residential and commercial uses are excluded from this zone.
- Forestry Zone – Areas zoned to allow forestry management and its related activities. No uses or structures are permitted in this zone unless they are for forestry uses. Saw and shake mills are conditional uses. Residential uses are permitted in limited circumstances in the Forestry zone.
- Wilderness Zone – Areas zoned to retain the natural environment. Individual residences, selective logging where conditions are appropriate, and individual campsites are a conditional use in this zone.

5.1.3 Shoreline Land Ownership

Land ownership on the Quinault Reservation includes the following categories: Quinault-owned, Fee, and Trust lands, with some allotments defined as a mixture of the categories. The majority of the SAA land is Trust land, followed by Quinault-owned land and fee land. Land ownership categories are defined in Section 3.6.

5.2 RESULTS: PACIFIC COAST

5.2.1 Current Land Use and Ownership

Coastal shoreline areas (all reaches combined) are predominantly zoned as wilderness (91%). Forestry makes up 7 percent of the zoning, residential is 2 percent, and commercial is less than 1 percent. Residential and commercial areas are associated with the Village of Taholah in Reach 2 (C2). Current land uses within the coastal SAA are typically low-impact land uses with little potential for affecting shoreline functions. They include traditional ceremonies (e.g., camping at Point Haynisisoos), Tribal recreation, and residential uses (e.g., cabins on the bluffs north of Queets). The coastline of the Reservation is off-limits to non-tribal members; non-members are not allowed access unless accompanied by a Tribal member. Thus, recreation in the area is likely low impact. While timber harvest is generally restricted in the Wilderness Zone, selective logging occurs where conditions are appropriate, as discussed under other reaches in this chapter.

The coastal SAA includes portions of the U.S. Highway 101 and State Route 109 ROWs, where the road runs along the coastal bluffs. State Route 109 travels through portions of C1, C2, and C3. U.S. Highway 101 travels through a small section of C4. Therefore, highway maintenance activities occur in coastal SAA areas. Critical culverts that require regular monitoring and maintenance have been mapped in the following reaches: four in C2, nine in C3, and one in C4

C1: Coast Reach 1 (C1) – South Reservation Boundary north to Point Haynisisoos (7.45 Shoreline Miles)

Land Use between Moclips and Point Haynisisoos is dominated by forestry, but includes residential use – several single-family homes are situated along State Route 109, starting about ½ mile north of Wreck Creek and continuing about ½ mile farther north. There appear to be several private beach access points from these home site lots, which provide for limited, individual recreation opportunities.

Recreation uses in this reach are common. The beach between Wreck Creek and Point Haynisisoos is easily available by car from the highway or on foot, and therefore provides for forms of recreation for Tribal members. Point Haynisisoos is an important cultural site, and is used for large gatherings and camping, and thus provides both recreation and important cultural land uses.

Ownership patterns along this reach are complex. From the southern boundary, north for about a mile, ownership is either Quinault Nation or Trust land. From that point, a small quarter mile section of narrow, linear fee land parcels (6 parcels, undeveloped) runs along the west side of the highway. From there, north, ownership alternates from Quinault or Trust land back to similar small fee-owned parcels about every quarter to half mile to Wreck Creek. The area around Wreck Creek is Trust land for about a mile. Many small lots run along the Shoreline for more than half the distance from there to Point Haynisisoos; about half of these parcels are

Quinault-owned; about half are fee-owned. The entire area around Point Haynisisoos is either in Trust or is owned by the QIN.

Zoning for the entire reach is Wilderness, aside from a small area upstream at the Wreck Creek outlet, which is zoned Forestry.

Coast Reach 2 (C2) – Point Haynisisoos to Pratt Cliffs (8.09 Shoreline Miles) (Taholah / Quinault River Reach)

Land Use between Point Haynisisoos and Taholah is dominated by Forestry. There are no home sites or significant structures until Taholah. Within Taholah, the primary land use is Residential, but also includes Commercial (stores), Industrial (salmon processing), and Governmental (agencies and schools) land uses. Buildings occur within 100 feet of the coastal MHHW line. Paved and unpaved roads also occur within the SAA.

Taholah also provides access to the River and beach, and thus also includes Recreational land uses, from individual access to providing access for guided hunting and fishing. Seagate Road, south of Taholah may also provide access to the beach for Recreational use. From Taholah north to Pratt Cliffs, land use is dominated by Forestry, with possible associated Recreational land use (hunting and fishing).

Ownership from Point Haynisisoos to Taholah is mostly either QIN or Trust, aside from a small section of mostly fee-owned parcels, which happen to directly abut or overlay an active landslide area (Figure 4), where the highway turns to parallel the coast south of Taholah. North of Taholah to Pratt Cliffs, ownership is either QIN or Trust, aside from a section about ½ mile long south of the outlet of Duck Creek, which is fee-owned.

Zoning for the entire reach is Wilderness, aside from the area around Taholah. Taholah is zoned Residential. A small forested upland rea south of Taholah is zoned Forestry.

Coast Reach 3 (C3) – Pratt Cliffs to Whale Creek (7.33 Shoreline Miles) (Raft River Reach)

Land Use between Pratt Cliffs and the Raft River (south of the River) is dominated by Forestry, but includes a few single-family homes. Land use north of the Raft is also dominated by Forestry, but also includes at least ten single-family homes (Residential use), which could be accessed only from the north (Queets area). There appear to be some private Beach access points, which provide for limited, individual Recreation opportunities.

The Raft River Estuary is an important cultural area for the QIN; thus, it provides forms of Recreation for Tribal members, but it is intentionally a limited access area.

Ownership for a 3,800 feet long section of Pratt Cliffs is Trust land or Quinault land, as well as about 5,000 feet of Shoreline south of Little Hogshead Island; about 1,600 feet of Shoreline south of the Raft River; and about 1,700 feet at the outlet of Whale Creek. The balance of ownership in this reach is dominated by Fee land parcels – over 130 individual fee lots with most being narrow, linear single-family size lots along the top of bluff.

Aside from a small area upstream at the Whale Creek outlet, which is zoned Forestry, the entire SAA along this reach is zoned Wilderness.

Coast Reach 4 (C4) – Whale Creek to Northern Reservation Boundary (Queets River Reach)

Land Use between Whale Creek and the Queets River (south of the River) is dominated by Forestry on the upper bluffs. Within the estuary and associated forested wetlands, which extend about a 1.5 miles north of the main river channel, land use is mostly Recreation, including commercial fishing. Land use north of the Queets estuary includes at least six home sites, but is mostly forested. There appears to be at least one private Beach access point, which provides for limited, individual Recreation opportunities.

Ownership along the bluff south of the River is about 60% in fee land, including over 44 small linear lots along the top of bluff, but also including some larger parcels near the mouth of the River, which cover the estuary along the southern side of the River and about 2,500 feet south along the upper bluff. The rest of the southern estuary is either in Quinault or Trust ownership. The estuary and associated forested wetlands upslope to the highway are in QIN or Trust ownership.

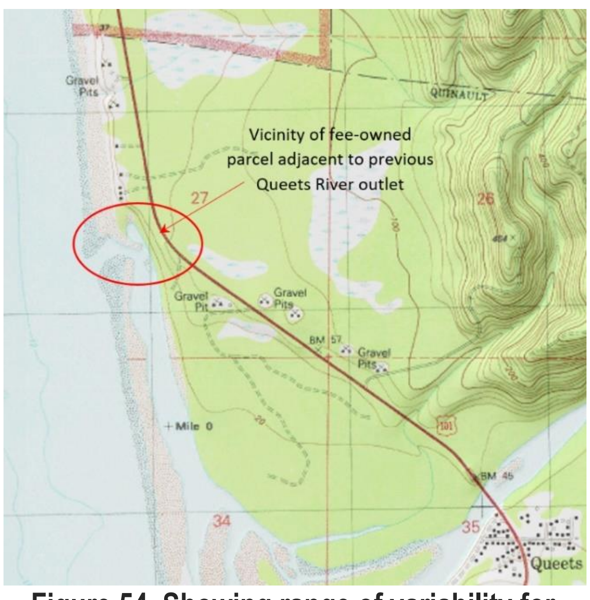

Figure 54. Showing range of variability for Queets River outlet in the past.

A large fee-owned parcel is located west of the highway where it curves north to parallel the Coast). The Beach west of this parcel is the northernmost migration zone for the mouth of the Quinault River, and is even mapped as a secondary outlet on the 1985 Matheny Ridge USGS Topo Map of the area (Figure 26)[41]. That parcel does not appear to have any significant structures at present, but includes some cleared areas, which may be used for parking. It also has a developed Beach access trail through the zone that was once a secondary outlet of the Queets River, which still includes some lagoon remnants of the old river channel.

For 1,000 feet north of the large fee-owned parking area parcel, there are six to seven home sites, and 14 narrow linear fee-owned parcels.

[41] Most of the estuary and river islands are north of the **current** river channel, which outlets to the Pacific only about 1,000 feet north of the southern coastal bluff. However, the river mouth has meandered more than a mile to the north in the past, as displayed in the Figure 24 USGS topography map.

Aside from two Quinault owned parcels (which appear to support a camping area) north of the homes, fee-owned land extends to the northern Reservation boundary.

Zoning for the entire SAA along this reach and up-river to the U.S. Highway 101 Bridge is Wilderness.

5.2.2 Future Land Use

Future land uses within the coastal SAA are likely to include uses similar to those occurring at present, including residential and recreational uses, traditional ceremonies, selective logging in wilderness areas, and highway and culvert maintenance.

The wilderness zoning over much of the coastal SAA along the coast will continue to regulate activities in this area. However, climate change and sea level rise will result in the need for emergency actions within this area with the potential to affect shoreline functions. Actions likely to occur include flood protection activities and slope stabilization work (e.g., plantings) within slope hazard areas. Additionally, erosion along the coastal bluffs has resulted in sloughing and landslides in various locations, and will likely continue to do so. Increased amounts of maintenance or reroute of U.S Highway 101 or State Route 109 may be necessary, particularly in Reaches C1 and C2.

The Lower Village of Taholah is currently within modeled tsunami and flood impact zones, and would likely be significantly impacted or destroyed in the event of large earthquake on the Cascadia Subduction Zone (Quinault Indian Nation 2016). The portion of the village within Coastal Reach 2 (and QN1) of the SAA is most at risk for flooding and impacts from tsunamis. The QIN is planning to relocate the village to an upland area northeast of its current location, which would be expected to have some effects on the SAA. This relocation effort has already started with preparation of the new village site.

5.3 RESULTS: QUEETS RIVER

5.3.1 Reach 1 (Q1) Estuary to MHHW elevation (2.34 River Miles)

Current Land Use and Ownership

Reach 1 of the Queets River SAA is located near the coast and includes the Queets River estuary. U.S. Highway 101 runs through this SAA and crosses the Queets River via a bridge. A small portion of the Village of Queets also occurs in this SAA. Approximately 71 percent of this reach is zoned as Wilderness, 28 percent is zoned as Forestry, 6 percent is zoned as residential, and 9 percent is zoned as commercial. No culverts or gravel pits have been mapped within this reach of the SAA.

The Village of Queets is a small development on the River with a few dozen buildings, only a few of which are located within the SAA. The population in 2010 was 174 (United States Census Bureau 2016). The village has a few paved and unpaved roads. The Village of Queets is considered a culturally significant area, and is therefore a priority area for invasive species control. Because of its position adjacent to forestland, the village is also a wildland-urban interface community and is at risk for wildfire. Fuel reduction projects are implemented in this area to minimize fire risk.

Riverfront Boulevard, an important local Transportation use, runs along the southern edge of the Queets River and provides recreational access to the estuary and beaches south of the River. It also provides for maintenance access and a physical barrier between the river and the Village of Queets sewage lagoons, located about 1,000 feet west of Queets on the lower terrace (within the floodplain).

Within the areas zoned as Wilderness, current land uses are generally low-impact land uses that include traditional ceremonies, Tribal recreation, and fishing. Timber harvest is generally restricted in this zone, although selective logging can occur where conditions are appropriate and if aesthetic and wilderness values of the site can be maintained (Title 48.05.060).

Within the areas zoned for forestry, land uses are associated with timber harvest, forest-based recreation, fishing, and hunting. Logging roads are present. Based on aerial imagery, a clearcut recently occurred within the SAA on the north side of the River.

An old bridge abutment (from an earlier highway bridge) along the south shore of the Queets River is used as an overlook, but also to hoist fish up from boats on the River – a Recreational and Commercial land use.

Ownership is 61 percent trust land, 25 percent Quinault-owned, and 15 percent fee land. Ownership along the main river channel and including the sewage lagoon area is mostly in Quinault or Trust ownership, but includes some parcels of fee land north of the main river channel on islands in the estuary. The estuary terrace and bluff facing the south side of the River mouth are mostly in fee ownership. The forested terraces and uplands north of the River are mostly in Trust ownership west of the U.S. Highway 101 Bridge; east of the bridge, the entire width of the floodplain and SAA is in Trust ownership.

Future Land Use

Future land uses within this reach are likely to include ongoing uses similar to those occurring at present, with low-impact land uses in areas zoned as wilderness, and timber management and other forestry practices occurring in areas zoned for forestry.

Given its location near the coast, the Village of Queets may be subject to an increasing frequency of flooding and tsunami risk with climate change and associated sea level rise. Although no plans have been made to date, this village may need to be relocated in the future, which could entail additional development within the SAA, depending on the selected new location.

Periodic maintenance activities will occur along the portion of U.S. Highway 101 within this SAA, as well as on roads within the Village of Queets. Climate change and continued sea level rise will likely contribute to increased flooding and erosion in this reach. Flood hazard reduction actions such as flood protection activities and slope stabilization work will likely occur.

Other future land uses in this reach will likely include Tribal recreation, traditional ceremonies, fishing, hunting, and camping. Fuels reduction in the wildland-urban interface will continue to be needed. Noxious weed control will continue to occur near Queets and in other locations as needed. Wildfire suppression actions may be needed in the event of wildfire.

5.3.2 Reach 2 (Q2) Reach 2 –MHHW to Reservation Boundary (6.32 River Miles)

Current Land Use and Ownership

Reach 2 is 99 percent zoned as Forestry, 8 percent zoned as Residential, and 1 percent zoned as residential. The residential portion of the SAA includes residential development associated with the Village of Queets, although only a few residences are currently within the SAA.

Land ownership is predominantly trust lands and Quinault-owned lands, with only 10 percent fee lands. Along the River near Jackson Heights ownership is predominantly Quinault, but the area includes some Trust lands. Moving upstream, most ownership is Quinault and Trust land, but two recent clearcuts—one near U.S. Highway 101 at the first big bend and one in the floodplain just around the bend—are both in Fee ownership. From there to the Reservation boundary, Trust-owned land dominates, with smaller sections of Quinault owned parcels, and two large fee-owned parcels.

Current land uses within the forested portions of this reach are like those discussed above for Reach 1. Logging roads occur within the SAA and aerial imagery shows evidence of a recent clearcut within the SAA. Current land uses associated with the Village of Queets are also like those discussed for Reach 1. No culverts or gravel pits have been mapped within this reach of the SAA.

Both commercial and recreational fishing occur within the floodplain. Upstream from the bridge, residents indicate that commercial fishing is limited by shallow water depth. Forestry dominates on the terrace just above the floodplain. Land use throughout Q2 includes a variety of Recreational uses, such as fishing and hunting.

The Clearwater Bridge provides an important Transportation use, providing the only other crossing of the Queets River, aside from the U.S. Highway 101 Bridge in Q1.

Future Land Use

The area within this reach that is zoned as residential includes a small portion of the development at the end of Jackson Heights Road. The area zoned for residential development extends all the way to the edge of the Queets River; development in this area could occur in the future if a need arises. Road and infrastructure maintenance will likely occur, as will fuels reduction actions within the wildland-urban interface and invasive species control in and around the village.

Within the areas zoned for forestry, timber management will continue to occur, following the guidance in the QIN Forestry Management Plan. Wildfire suppression activities may occur if the need arises. Other forest-based land uses will include other types of plant harvest, recreation, and hunting. Maintenance of forestry roads may occur, as needed. Along the River, boat use will occur, as will fishing, both from the land and shore.

5.4 RESULTS: SALMON RIVER

5.4.1 Reach 1 (S1), Reach 2 (S2) and Reach 3 (S3)

Current Land Use and Ownership

For all three reaches of the Salmon River, zoning is 100 percent forestry. Evidence of recent timber harvest is apparent from aerial imagery at several locations along the River. Land use based on the state GIS layer is a mix of various types of forest land, open space, and undeveloped land. In addition to forestry, land uses in these reaches include some recreational fishing and hunting.

Reach 1 terminates at the Salmon River fish hatchery weir. The hatchery is the only developed area within the Salmon River SAA, apart from roads. The hatchery has facilities for egg-take, spawning, incubation, and rearing of coho, chinook, and winter steelhead (Washington Coast Sustainable Salmon Partnership 2013). The weir, which crosses the Salmon River, is used to draw water for the hatchery. Fishing occurs on the Salmon River, both by boat and from the shore.

No gravel pits have been mapped in either reach of the Salmon River SAA. No culverts have been mapped in Reach 1. However, two culverts have been mapped in the western portion of Reach 2. They appear to be associated with dirt forestry/logging roads that are shown on aerial imagery. Additionally, there is a well-constructed gravel road leading from U.S. Highway 101 to the fish hatchery. In Reach 3, NF 2446 (a major Forest Service road) runs along the western boundary of the SAA.

Ownership is Quinault-owned (54%) and Trust land (44%), with 2 percent falling in the Miscellaneous category. In Reach S1, Ownership in the downstream section is about half QIN Ownership, with a small area of Trust land, but also includes about 30% ownership simply classified as “Other” (i.e., not Trust, Quinault or fee-owned land). This portion of the Reservation was added later than most the area to the south, and thus may include some parcels that were previously privately owned. Ownership on all parcels around the Fish Hatchery is by the QIN. In Reach S2, ownership in the western half is Trust land with minor inclusions of Quinault Tribal ownership, and in the eastern half is all Quinault Tribal ownership. Ownership in Reach S3 is all Quinault Tribal ownership.

Future Land Use

Within the Salmon River SAA, timber management will continue to occur, following the guidance in the QIN Forestry Management Plan. Wildfire suppression activities may occur if the need arises. Other forest-based land uses will include other types of plant harvest, recreation, and hunting. Maintenance of forestry roads may occur, as needed. Along the River, boat use will occur, as will fishing, both from the land and shore.

Operation of the fish hatchery in S1 will continue to occur, including use of the weir to draw water. Future development associated with the hatchery is a possibility in this area. The existing facility and infrastructure will need to be maintained. Maintenance of the road leading to the hatchery, as well as other roads in the SAA will also be needed periodically.

5.5 RESULTS: RAFT RIVER

5.5.1 Reach 1 (R1) – Estuary to MHHW elevation (2.65 River Miles)

Current Land Use and Ownership

Reach 1 of the Raft River SAA meets up with the coastal SAA at the estuary at the mouth of the Raft River. There is no development in this reach. Zoning is 73 percent Forestry and 27 percent Wilderness. Based on state data, land use is designated forest land and non-commercial forest, with a very small amount of undeveloped land. Ownership is mostly Fee land in the western portion of the reach and Quinault-owned land in the eastern portion of the reach, with less than 25 percent Trust Land. Land use within this reach is dominated by cultural uses, but may also include forestry, hunting, and recreational fishing within the floodplain.

Within the areas zoned as Wilderness (west of the washed out old State Route 109 Bridge), current land uses are generally low-impact uses such as traditional ceremonies, Tribal recreation, and fishing. Timber harvest is generally restricted in this zone, although selective logging can occur where conditions are appropriate and if aesthetic and wilderness values of the site can be maintained. Forestry occurs on the terrace above the floodplain.

Within the areas zoned for Forestry (east of the washed-out bridge), land uses are associated with timber harvest, forest-based recreation, and hunting. Logging roads are present. Two culverts have been mapped in this reach which appear to correspond to locations where roads

Future Land Use

Future land uses within this reach are likely to include ongoing uses like those occurring at present, with low-impact land uses in areas zoned as Wilderness, and timber management and other forestry practices occurring in areas zoned for Forestry.

Climate change and continued sea level rise will likely contribute to increased flooding and erosion in this reach. Flood hazard reduction actions will likely be needed.

Other future land uses in this reach will likely include Tribal recreation, traditional ceremonies, fishing, hunting, and camping. Wildfire suppression actions may be needed in the event of wildfire.

5.5.2 Reach 2 (R2) – MHHW to east end of D-River (11.90 River Miles)

Current Land Use and Ownership

Reach 2 of the Raft River SAA is 100 percent zoned as Forestry. The Ecology database indicates that land use is a mix of designated forest and noncommercial forest, with 2 percent undeveloped land. Similar to Reach 1, land use is dominated by forestry, but also includes recreational fishing and hunting within the floodplain. Residential land uses are not apparent in this reach.

Numerous culverts have been mapped within the SAA in this reach. Additionally, one gravel pit has been mapped within this reach. Local logging roads provide critical Transportation uses in this remote part of the Reservation, including at least one bridge crossing of the Raft River within the upstream portions of the reach.

Land ownership is 58 percent Fee lands, 20 percent Quinault-owned lands, 5 percent Trust lands, and 17 percent a mix of Quinault and Trust lands. Along the river up to the confluences with the North Fork Raft, ownership is mostly QIN; but there is a small area of Trust Land along the north side of the River at one location, and two large fee parcels. From the confluence, upstream, ownership within the reach is approximately 80% fee-ownership, with minor inclusions of QIN and Trust ownership.

Future Land Use

Timber management and other forestry-related land uses will continue to occur in this reach. Wildfire suppression activities may occur if the need arises. Other forest-based land uses include other types of plant harvest, recreation, and hunting. Maintenance of forestry roads may occur, as needed. Along the River, boat use will occur, as will fishing, both from the land and shore. Future development is not anticipated. The gravel pit in this SAA may be used intermittently on a relatively small scale.

5.6 RESULTS: NORTH FORK RAFT RIVER

5.6.1 Reach 1 (NR1) – Confluence with the Raft River upstream to end of D-River (3.06 River Miles)

Current Land Use and Ownership

The North Fork Raft River SAA (NR) is 100% zoned for Forestry, and its land use is mapped 100% as forestry. There is no development within this SAA, and no evidence of recent large-scale timber harvest from aerial photos. Residential land use is also not apparent. Local logging roads provide critical Transportation uses in this remote part of the Reservation, including two possible bridge crossings in the upstream portions of the Reach.

Land uses within this river SAA are associated with forestry, forest-based recreation, and hunting/fishing. The river and shoreline are likely used for both recreation and fishing. Two culverts have been mapped within this SAA reach. No gravel pits have been mapped within this reach.

Ownership is predominantly Quinault-owned land (73%), with lesser amounts of Trust and Fee lands. Ownership at the confluence with the Raft River is fee-land, but most of the upstream portions of the reach o in Quinault Tribal ownership, except for two areas in Trust.

Future Land Use

Future land uses in this area will continue to be associated with forestry-related activities, recreation, and hunting/fishing. Wildfire and associated wildfire suppression are future possibilities that could affect shoreline functions within this SAA. Future development is not anticipated in this area.

5.7 RESULTS: QUINAULT RIVER

The Quinault River SAA is predominantly forested habitat that is zoned for forestry and supports forestry uses, with evidence of recent timber harvest in certain areas apparent from aerial photos. Residential development is generally limited to Reach 1 near the Pacific Coast and Reach 3 near the Lake Quinault outflow.

It is likely that invasive species control will be needed in the future within all reaches of the SAA.

5.7.1 Reach 1 (QN1) – Estuary to MHHW elevation (2.57 River Miles)

Current Land Use and Ownership

Within this reach of the Quinault River near the coast, land is zoned mostly Forestry (66%) and Residential (27%), with very small amounts of Wilderness (5%) and Commercial (3%). Zoning west of the State Route 109 Bridge and north of the River is Wilderness. Zoning in the Village of Taholah and extending upstream about 2,000 feet east of the State Route 109 Bridge is mostly residential with some Commercial inclusions. Zoning around the government building complex upslope to the southeast is commercial. The balance of the SAA in this reach is zoned Forestry.

The Village of Taholah is located within this reach. Its population in 2010 was 840 (United States Census Bureau 2016). This area includes a network of roads, residences, administration buildings, schools, medical facilities, and other development in support of the community. Taholah includes several commercial businesses, such as the gas station on Quinault Street, which also includes a restaurant and mini-mart. South of the Quinault River and east of the bridge, some residential development is present, as well as what appears to be a sewage treatment system for the governmental buildings at the top of the hill to the south. Transportation uses include State Route 109 from the south, which crosses the Quinault, then becomes Cape Elizabeth Road, which provides a vital connection to the Raft River and areas to the north. In addition, roads within Taholah and those connecting to various governmental facilities to the south and southeast are vital to the community.

Forestry is a land use on the floodplain terrace upstream of the bridge, north of the river. Based on cleared areas visible on recent aerial photos, recent timber harvest has occurred within the SAA on the north bank of the Quinault River. Two gravel pits have been mapped within this SAA reach. Additionally, nine culverts have been mapped within this reach: one associated with State Route 109, two associated with BIA Road 7000, and the remainder apparently associated with forestry/logging roads.

Fishing occurs within the SAA, including both commercial and sustenance fishing. Recreational use of the area is limited to Tribal members (or guests of Tribal members), and includes both coastal and forestry-based activities.

The Village of Taholah is identified in the Forestry Management Plan as a culturally significant area, which is a priority for invasive species control.

Land ownership is a mix of Trust, Quinault-owned, and Fee lands. Ownership throughout Taholah, and extending upstream about 3,400 feet above the State Route 109 Bridge, and including governmental areas to the south and southeast is all by the QIN. North of Taholah on the opposite bluff, and including both sides of Cape Elizabeth Road, the land is in Trust Ownership, and the last upstream mile of the reach is also mostly in Trust ownership, aside from two parcels that are fee land north of the River.

Future Land Use

As discussed under the Coastal SAA below, the Lower Village of Taholah within this reach is currently within modeled tsunami and flood impact zones. The QIN is planning to relocate the lower village to a site further upstream, near the current location of the Health Center. This action will occur partially within the SAA, and will entail vegetation clearing, ground disturbance, construction of roads, sidewalks, and buildings, and other activities associated with development of the new village. The site would be harvested prior to clearing and then converted to non-forestry uses.

Outside of Taholah, ongoing forestry uses would occur within the SAA. Taholah is considered to be a wildland-urban interface community, as specified in the QIN draft Forest Management Plan (Bureau of Indian Affairs 2015). Because of the risk associated with wildland fuels buildup, forested areas adjacent to Taholah are subject to vegetation management projects to reduce fuels. Other types of timber harvest and associated forestry activities are likely to continue to occur in the SAA outside of the wildland-urban interface.

Because QN1 is located close to the coast, actions in response to climate change and sea level rise are likely to occur within this SAA. Required actions could include flood protection activities and slope stabilization. Increased amounts of maintenance or reroute of U.S. Highway 101 and State Route 109 may also be necessary. The gravel pits in this SAA may be used intermittently on a relatively small scale.

Future use of this area for fishing and recreational activities, as at present, is likely to occur.

5.7.2 Reach 2 (QN2) and Reach 3 (QN3)

Current Land Use and Ownership

In QN2 and QN3, 100% of the land within the SAA is zoned as Forestry, and 100% of the land use is mapped as Forestry (except for recent clearcuts mapped as undeveloped land).

Based on land use and zoning, current land uses in these two reaches are largely associated with forestry and forest-based recreation. Commercial and recreational fishing and hunting also likely occur. Aerial photos of the site indicate recent timber harvest at various locations. Recreational uses of the SAA include hiking, camping, boating on the River, and fishing (both by boat and from shore).

There are many BIA roads in and near these two reaches, which are assumed to provide access to many parts of the Reservation that would otherwise be inaccessible. There are three gravel pits mapped within QN2, but none mapped within QN3. Culverts are widespread, with more than 20 mapped in each of the two reaches. No residential uses are apparent in either reach.

Land ownership is primarily Trust land (72%) and Quinault-owned land (18%), with a small amount of Fee land (3%). The remainder of the parcels are a mix of the three types of land ownership. In QN2, ownership is about 80% Trust land, with five semi-isolated and scattered fee-owned parcel that total approximately 240 acres. The rest of the land is in Quinault Tribal ownership. In QN3, ownership is about 70% Trust land, with five semi-isolated and scattered fee-owned parcel that total approximately 200 acres. The rest of the parcels (about 1,500 acres) is in Quinault Tribal ownership.

Future Land Use

Future land uses within QN2 and QN3 are likely to be similar to those occurring at present. Timber harvest and other forestry-related activities will continue to be important, as will recreational activities. Maintenance of forestry roads and associated culverts will be needed periodically. Should wildfire occur within these two reaches, wildfire suppression activities may be needed. Ongoing control of knotweeds and other invasive species is also likely to occur. The gravels pit in this SAA may be used intermittently on a relatively small scale.

5.7.3 Reach 4 (QN4) –Narrows near U.S. Highway 101 Bridge to edge of Lake Quinault (1.72 River Miles)

Current Land Use and Ownership

Reach 4 of the Quinault River includes a portion of the Village of Amanda Park and the U.S. Highway 101 Bridge crossing, in addition to a large component of forested land. It also includes the Lake Quinault outflow. Current zoning is 71% Forestry, 26% Residential, and 3% Commercial. Land use is predominantly a mix of designated forest land/noncommercial forest/public timberland (90%), with the remainder falling under residential (7%), retail trade (1%), hotels/motels (1%), and undeveloped land (1%).

Within the portion of Amanda Park in the SAA, development includes private residences, seasonal vacation homes, the Quinault River Inn, and some commercial buildings (stores, hotels). Industrial (light manufacturing and wood products) and governmental uses (school, Post Office) also occur. The main roadway is U.S. Highway 101 and its associated ROW, and other smaller roads are present within Amanda Park. Transportation is an important use, as the U.S. Highway 101 Bridge is the only road available for non-tribal people to access areas north of the Quinault River. There are many BIA roads in and near the SAA provide access to parts of the Reservation that would otherwise be inaccessible. There are no culverts or gravel pits mapped within this reach of the SAA.

In the areas designated for Forestry, current land use is associated with timber harvest, maintenance of access roads, and recreation. Hunting is limited by proximity to residential and commercial development. Recreation occurs on the Quinault River and along the shoreline. Fishing also occurs on the River by boat and from the shore.

Control of knotweeds and other invasive weeds occurs in this reach, as necessary.

Ownership is 53% Trust Land, 16% Fee Land, and 15% Quinault-owned Land, with the remainder of parcel some mix of these. Ownership in the southern half of the SAA and on the eastern side of the river is about 60% Trust land and 40% Quinault Tribal Land. On the west side of the river on both sides of the highway, parcels are much smaller on average and more numerous. Ownership is about 60% fee land and about 40% Quinault Tribal land. The QIN owns both sides of the river at its outlet.

Future Land Use

While it is not anticipated that Amanda Park will see substantial future population growth, the area zoned as residential is largely undeveloped. Therefore, it is expected that additional residential and possibly commercial development of this area could occur. Some additional development for recreation/tourism could occur.

Amanda Park is considered a wildland-urban interface community, as specified in the Draft QIN Forest Management Plan (Bureau of Indian Affairs 2015). Because of the risk associated with wildland fuels buildup, forested areas adjacent to Amanda Park are subject to vegetation management projects to reduce fuels. Other types of timber harvest and associated forestry activities are likely to continue to occur in the SAA, as guided by the QIN Forest Management Plan.

Maintenance actions along U.S. Highway 101 and other roads within this SAA will continue to occur, as will any infrastructure upgrades/maintenance needed to support the community of Amanda Park. Recreation on Lake Quinault, the Quinault River, and associated shorelines will likely continue to occur and may possibly increase in the future. Noxious weed control and other vegetation management will also continue to occur.

5.8 Results: Wreck Creek

5.8.1 Reach 1 (WC1) – State Route 109 Bridge upstream to confluence with the North Fork Wreck and Baker Creek (0.69 River Miles)

Current Land Use and Ownership

The Wreck Creek SAA (WC1) is 100% zoned for Forestry, and its land use is mapped 100% as forestry. There is no development within this SAA, and no evidence of recent large-scale timber harvest from aerial photos. Transportation is an important use, as the highway and bridge provide the primary access to points south from Taholah. Some local logging roads may be used to access the Moclips Highway, but their condition could not be guaranteed following a major earthquake. No culverts or gravel pits have been mapped within this SAA. Land uses within this reach are associated with forestry, forest-based recreation, and hunting/fishing. The river and shoreline are likely used for both recreation and fishing. There is no Residential land use within this reach, although there are nearby residences to the north and south along this section of the coast.

Ownership in the Wreck Creek SAA is nearly all Trust land, with just a small section of Quinault-owned land at its eastern (upstream) end.

Future Land Use

Future land uses in this area will continue to be associated with forestry-related activities, recreation, and hunting/fishing. Wildfire is a future possibility that could affect shoreline functions within this portion of the SAA. Future development is not anticipated in this area.

5.9 RESULTS: MOCLIPS RIVER

5.9.1 Reach 1 (M1) 1 – southern Reservation boundary to North Fork Moclips (1.04 River Miles)

Current Land Use and Ownership

The Moclips River SAA (M1) is 100% zoned for Forestry, and its land use is mapped 100% as forestry. It is a mix of Trust land (60%) and Quinault-owned land (40%). There is no development within this portion of the SAA, although at least one small structure is visible from aerial imagery. A small stretch of the Moclips Highway runs within this portion of the SAA. Two culverts are mapped within this portion of the SAA, one associated with the Moclips Highway and one apparently associated with a smaller forestry/logging road. Land uses within this reach are associated with forestry, forest-based recreation, and hunting/fishing. The river and shoreline are likely used for both recreation and fishing.

There is no Residential land use within the Moclips SAA, although there is a residential subdivision in the forest about 1700 feet to the northwest. The town of Moclips is not on the Reservation, but is directly south of the boundary with many Quinault Tribal member residents.

Future Land Use

Future land uses in this area will continue to be associated with forestry-related activities, recreation, and hunting/fishing. Maintenance of roads and culverts may be needed. Wildfire is a future possibility that could affect shoreline functions within this portion of the SAA. Future development is not anticipated in this area.

5.10 RESULTS: LAKE QUINAULT

5.10.1 North and South Shores (LQN and LQS) – Southern and Northern Shoreline extending to northeast inflow of Quinault River

Lands upslope of the Lake Quinault OHWM in this area are not within the Reservation and therefore not regulated by the Quinault Indian Nation. Although the SAA covered by this report does not include the north or south shores of the lake, land uses in these areas are still considered, as they may affect water quality and therefore lake shorelines within the SAA. These areas are within the management jurisdiction of Grays Harbor County.

The north shore is under public ownership as part of the Olympic National Park. The south shore includes a mixture of private and National Forest lands. Shoreline areas outside the Reservation predominantly support recreation, and along much of the lake have been developed for resorts, vacation homes, cabins, and other recreational facilities. Forestry-related activities likely occur on nearby National Forest lands.

Land Use within LQS and LQN is dominated by residential development and some commercial development, predominantly resorts and hotels. At the far north end of the lake, land use includes ranching and farming and some forestry.

Ownership along the southern Lake shoreline is National Forest, and along the northern shoreline is a combination of National Park and private land ownership.

Zoning along the South Shoreline (LQS) is controlled by Grays Harbor County, and is "LQ – Lake Quinault Residential", which allows a wide range of uses: Single family and two-family dwellings; One attached accessory dwelling for each single-family dwelling; Accessory structures and uses; Home occupations; Bed and breakfast inns; Public and semi-public uses and structures; Agriculture; The growing and harvesting of forest products; Parking, repairing, and maintaining one heavy truck as an accessory use to a residence; Home day cares; Adult family homes; Utilities and utility structures under thirty-five feet in height, provided all transmission lines are underground; Temporary fireworks stands regulated under RCW 70.77 and WAC 122-17; Game and fish rearing and management; Mini-storage building(s) including covered RV and boat storage when each of the following criteria is met: 1. The site must conform to minimum lot size; 2. The site fronts on a minor collector, major collector, state or federal highway; 3. Any light, glare, and signage shall be directed away from adjacent properties; 4. An adequate stormwater drainage system will be developed.

Zoning along the North Shoreline (LQN) is not identified in the Grays Harbor County Zoning map system, but most of the privately-owned lots are described as "Household, single-Family", and most of the Olympic National Park-owned lots are described as "Hotels/Motels" or "Undeveloped Land."

5.10.2 Southwest Reach (LQW) Southwest Shoreline within the Reservation, Amanda Park area (2.63 Shoreline Miles)

Current Land Use and Ownership

Lake Quinault is owned by the QIN, but shoreline area under QIN management is limited to the section on the Reservation. As described previously, the SAA is limited to a 200-foot buffer zone at the edge of the lake (southwest shore). Within the SAA, land uses are private and public forest, and residential. Zoning is a mixture of Forestry and Residential. Forestry land uses are predominant on the east side of the Quinault River, and residential developed occurs on the west side of the river.

The LQW reach is located in and near the community of Amanda Park. The population of Amanda Park in 2010 was 252 (United States Census Bureau 2016). Residential dwellings occur within the SAA. A few roads are also located within the SAA, as is the Quinault hatchery and net pens facility, located near the eastern end of the SAA. No culverts or gravel pits have been mapped within this portion of the SAA.

Land ownership is a mixture of Quinault-owned, Trust, and Fee land. Ownership along the lake shoreline east of the Quinault River is mostly in Trust Land, except for the eastern river edge and the hatchery/net pen facility near the eastern end of LQW. Ownership along the lake shoreline directly west of the River is QIN, but farther west, for about 1,500 feet along the shoreline, there are many small fee-owned parcels, many with home sites. There is another fee-owned parcel with a home site on the shoreline west of the school at Amanda Park, but the rest of LQW is in Quinault Tribal ownership.

Future Land Use

Amanda Park is considered to be a wildland-urban interface community, as specified in the Draft QIN Forest Management Plan (Bureau of Indian affairs 2015). Because of the risk associated with wildland fuels buildup, forested areas adjacent to Amanda Park are subject to vegetation management projects to reduce fuels. Other types of timber harvest and associated forestry activities are likely to continue to occur in the SAA, as guided by the Forest Management Plan. Additionally, timber harvest, wildfires, and wildfire suppression efforts on lands adjacent to Lake Quinault that are outside the Reservation would be expected to impact water quality on Lake Quinault. Control of noxious weeds, as needed, is also likely to occur.

6. OPPORTUNITIES FOR ENHANCEMENT AND CONSERVATION OF SHORELINE ECOLOGICAL FUNCTIONS

This section identifies opportunities for the conservation and enhancement of shoreline ecological functions based upon the reach analyses described in Section 4. These actions, when combined with anticipated shoreline developments, natural hazards, and uses, provide opportunities to maintain or improve the net ecological functions provided to the Quinault by their shoreline areas. The enhancement opportunities are organized by marine coastline, individual rivers, and Lake Quinault.

6.1 COASTAL SHORELINES

The primary short term concerns along coastal areas are slope instability/landslide hazard associated with development along the bluff and wave action areas, and the potential for authorized and unauthorized recreational use of beach areas which may degrade important cultural and ecological resources. Long-term concerns along coastal areas include sea level rise and changes to the tsunami inundation areas upon which land use plans are based. The following opportunities for enhancement include recommendations for policy and management approaches as well as for site specific potential enhancement projects which are intended to address these coastal concerns. Shallow groundwater seeping from the top of slope at marine bluffs is a major factor affecting slope instability and erosion along the Quinault marine coastline. Some of this is a natural process which will result in gradual bluff retreat over time and cannot be entirely eliminated. There are several potential approaches that can be used to restore impacts and to reduce or minimize future impacts of development to the Shoreline environment, specifically targeted to reduce or restore impacts of marine bluff erosion and landslides: Revegetate currently eroding areas caused by development; Design better stormwater management facilities in areas with excessive clearing or impervious surface in Shoreline areas; Setback development from the top of slope; Ensure that no more water is directed to the top of the bluff than would occur under undeveloped conditions.

6.1.1 Coastal Shorelines Policy and Management Recommendations

- Minimize potential for accelerated erosion and mass wasting resulting from development or other land management activities by maintaining mature native vegetation at the top of slope for a distance of either 200 feet or, for taller bluff areas, at a distance defined by a 2:1 slope from the unvegetated bluff toe slope (mean high tide line). This ensures that deep roots bind soil at the edge of the bluff, and increases the opportunity for transpiration rather than runoff to translocate groundwater out of soil during wet season.
- Strive for maintaining or planting a majority of conifer trees in Shoreline areas, to ensure that onsite vegetation continues to pull water from the soils through transpiration processes during wet months when deciduous trees are dormant.
- Stabilize areas of human-affected beach/bluff erosion with natural armoring materials, including woody debris and deep-rooted live native shrub and tree plantings.
- In Shoreline areas without marine bluffs, maintain a minimum 200-foot setback for development from mean high tide line and from coastal lagoons. If the setback is reduced, provide a mitigation plan to compensate for impacts, and to ensure that natural ecosystem functions and water quality treatment / water quantity management functions adjacent to the shoreline are not lost.
- Ensure that stormwater runoff from any developed site is managed through an engineered design, directing flow away from the top of bluffs or intermediary slopes into stormwater detention facilities with controlled or dispersed release to stable, vegetated areas for natural infiltration.
- Prohibit or limit the creation of new impervious surfaces on landslide-prone bluff areas.
- Restrict pedestrian access to areas prone to erosion or slope failure, using natural barriers if possible, but fencing and signage as needed to identify the area as being dangerous and/or environmentally sensitive.
- When designing coastal roads and developments, merge tsunami and earthquake preparedness with climate change response planning to identify areas (such as the State

Route 109 crossing at Wreck Creek) with increased potential for flooding from a combination of sea-level rise and increased winter runoff.
- Increase pace of plans to move highways away from the shoreline and to develop improved and marked alternate inland routes for areas vulnerable to tsunami or flooding impacts to transportation.

6.1.2 Site-Specific Opportunities for Restoration and Enhancement in Coastal Shoreline Areas

Point Haynisisoos Enhancement Opportunities:

- The cleared gathering area currently directs runoff to top of slope, which is causing severe erosion at a minimum of two locations. Runoff from impervious areas should be collected and redirected to designed detention ponds away from the top of the bluff, then released to spreader devices located in naturally vegetated areas away from the top of slope for infiltration.
- Create designated trails with boardwalks to reduce impacts to soil and to reduce surface erosion
- Block off and naturally revegetate actively eroding dirt trail sections that have removed stabilizing vegetation in certain steep areas along the south side of the Point. Replace access with boardwalks or designed viewpoints in more stable areas.
- Provide restrooms and garbage management services for year-round use by individual campers.

Wreck Creek Vicinity Beach Access Enhancement Opportunities:

- Install signage at access points where cars commonly drive onto the beach, to reduce unauthorized use by non-tribal visitors, and help Tribal member avoid natural hazards, such as crossing at Wreck Creek with a vehicle.
- Build a public restroom and provide for garbage services at the entry point.

Reach C1 and C2: Impacts to State Route 109 Enhancement Opportunities:

- Where State Route 109 runs parallel to the coast within the SAA, replace undersized and blocked culverts (documented in QDNR databases) with fish-friendly culverts to avoid wash-outs, and improve fish passage.
- Any runoff from pipes through any culverts along State Route 109 should be tight-lined to the toe slope or directed to effective energy dissipater devices to minimize erosion and hydraulic loading on unstable slopes west of the highway.
- Restore areas of cleared vegetation on the marine bluff downslope of existing residential lots west of the highway in area of dense residential development between

Wreck Creek and Point Haynisisoos, including removal/restoration of unpermitted, unstable and eroding trails in the bluff face, built for beach access.42

- Avoid or minimize development of lots west of the highway. If allowed, each lot would develop and carry out a shoreline mitigation plan intended to protect native vegetation and minimize clearing within 200 feet of top of slope. All stormwater runoff should be infiltrated more than 100 feet from the top of bluff, or should be securely tight-lined to toe slope.

Raft River Estuary Access and Use Enhancement Opportunities:

- Design a dedicated route and improved walking trail to the beach, to minimize random access points and impacts to vegetation and soils, while still ensuring that Tribal Elders have access.
- Design a dedicated route and improved trail for ATV access, to minimize random access points and impacts to vegetation and soils, while still ensuring that Tribal Elders have access.
- Develop dedicated camp sites in the Raft River estuary area with properly designed and sited outhouses and garbage management.

Queets Estuary Access and Use Enhancement Opportunities:

- Design a dedicated route and improved walking trail to the beach from the end of Riverside Road at Queets, to minimize random access points and impacts to vegetation and soils, while still ensuring that Tribal member have access for hunting, fishing and other uses.
- Team with Audubon to identify funding for replanting grassed uplands in the Conservation Area south of the Queets River (Figure 55) with a suite of native species, to reduce cover by reed canarygrass and to enhance wildlife habitat and water quality.

- While still providing fishing access, target areas along southern bank of Queets River (See eroded banks at northern end of restoration area in Figure above) for bioengineering improvement, using an installation of willow stakes at 2 ft. intervals in eroding areas to stabilize the bank and reduce soil erosion between fishing access sites.
- Install signage about restrictions to Beach access and restore the cleared trail area through the Queets River floodplain to the Beach west of the fee-owned parcel with a parking lot, located west of the highway bend, north of Queets (Figure 56).[43]

[42] Access to Quinault Beaches by non-tribal individuals is not allowed unless accompanied by a tribal member.

[43] Access to Quinault Beaches by non-tribal individuals is not allowed unless accompanied by a tribal member.

Figure 56. Native Vegetation Community Restoration Area by Queets River.

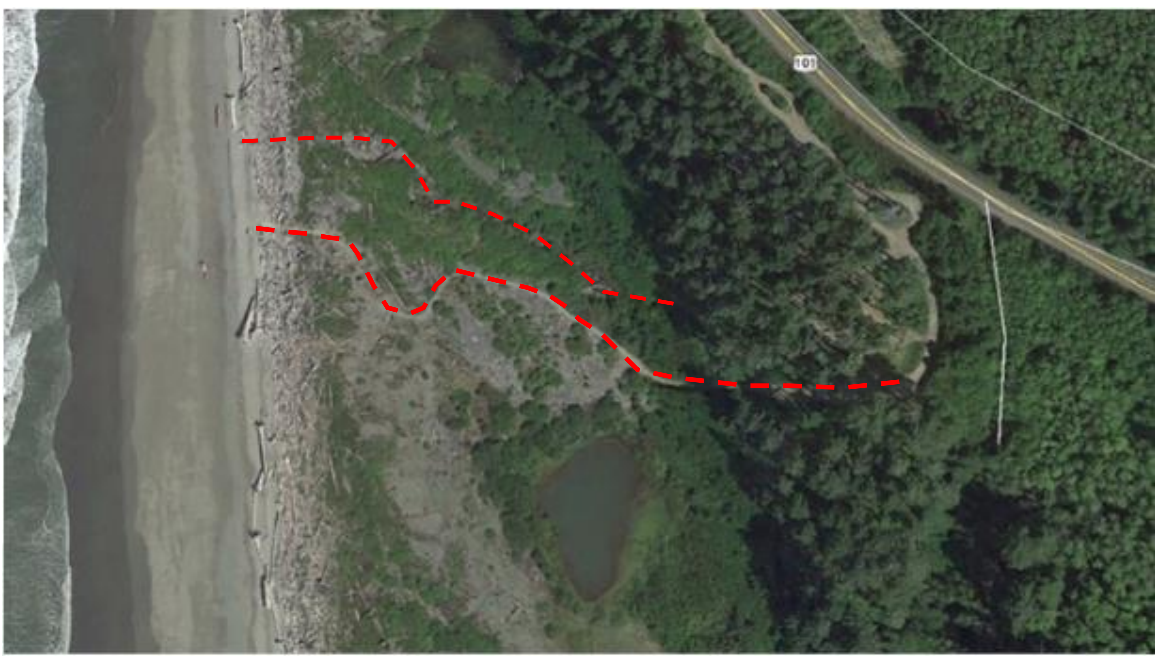

Figure 55. Showing trail access from fee-owned lot north of the Queets River. Beach access is not allow by non-tribal members unless they are accompanied by a Tribal representative.

6.2 RIVERINE SHORELINES POLICY AND MANAGEMENT RECOMMENDATIONS

Concerns for the Riverine Shoreline Analysis Areas in the Reservation include protection and improvement of salmonid habitat, while still protecting and enhancing shoreline access opportunities. Opportunities for site-specific enhancement in each River system are described below, and are intended to address these concerns.

- Minimize potential for accelerated erosion and mass wasting resulting from development or other land management activities by maintaining at least 75% cover of mature native vegetation in the Shoreline Analysis Area, within 200 feet from the edge of the floodplain. This ensures that deep roots bind soil at the edge of the river terraces, and increases the opportunity for transpiration rather than runoff to translocate groundwater out of soil during wet season.
- If the setback is reduced, develop a mitigation plan that describes how the project will compensate for impacts, and will ensure that natural ecosystem functions and water quality treatment / water quantity management functions adjacent to the shoreline are not lost.
- Maintain or plant a majority of conifer trees in Shoreline areas, to ensure that onsite vegetation continues to pull water from the soils through transpiration processes during wet months when deciduous trees are dormant. This also ensures a long-term supply of coarse woody debris for riverine habitat needs at the river edge from natural erosion and channel migration processes.
- Stabilize areas of human-affected erosion along river banks and terraces with natural armoring materials, including strategic placement of woody debris and deep-rooted live native shrub and tree plantings. Only use hard armoring if bioengineering solutions are not practical or feasible.
- Ensure that stormwater runoff from a developed site is managed through an engineered stormwater design, directing flow away from the top of the riverine terrace into stormwater detention facilities[44] with controlled or dispersed release to stable, vegetated areas for natural infiltration.
- Prohibit or minimize creation of new impervious surfaces within the Shoreline Analysis Area.
- Restrict or safely manage pedestrian and ATV access to areas prone to erosion, using natural barriers if possible, but fencing and signage as needed to identify the area as being dangerous and/or environmentally sensitive.

[44] Rain gardens may be used at individual residential settings to detain and infiltrate stormwater; larger stormwater facilities will be needed for commercial development sites.

- Prioritize and focus fee lands buy-back efforts where gaps exist between designated riparian reserves[45] to create more functional wildlife migration corridors and ensure riparian habitat functionality.
- Enforce riparian setback buffers during logging and road building activities to protect water quality, shade (to maintain water temperature), and bank stability. Identify opportunities for improved fish passage based on monitoring data, and including removal of fish passage barriers.
- Decommission old logging roads within SAAs and restore by planting riparian vegetation.

6.2.1 Site-Specific Opportunities for Restoration and Enhancement in the Queets River System

Concerns for the Queets River Shoreline Analysis Areas include protection and improvement of salmonid habitat in the Queets River estuary (Q1) and along the River (Q2), while still protecting and enhancing shoreline access opportunities. Informal, random river access has created a network of trails and roads that remove stabilizing shoreline vegetation. The trails along the riverbank near Queets village are often steep and unsafe, and increase the potential for erosion. The opportunities for enhancement described below are intended to address these concerns.

- Enhance riverbank access points along the eroding and unstable southern riverbank at Queets, north of the old bridge crossing, by installing steps or sand ladders to increase safety and reduce impacts to soils and vegetation along the shoreline.
- Prioritize shoreline-dependent land uses, including design and construction of fishing facilities and safe boat access ramps, based on the existing character of shorelines and the presence of existing fisheries infrastructure.
- Restore vegetation[46] around eroding riverbank access points at Queets and at existing informal boat access areas to reduce erosion, and improve access safety.
- Restrict vehicle access through riparian areas or provide formal access routes to prevent dispersed driving.

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[45] Current riparian reserves are designated in the QIN Forest Management Plan.

[46] Bioenginering techniques using willow stakes interplanted with other native plants have been used with great success to restore riverbanks in other coastal Washington river systems.

6.2.2 Site-Specific Opportunities for Restoration and Enhancement in the Salmon River System

The Salmon River runs through some densely forested portions of the Reservation. Past and ongoing logging operations have created areas of young forest within its shoreline areas. This provides opportunities for riparian conservation by thinning to encourage healthy forest conditions that benefit the abundant wildlife in this relatively remote portion of the Reservation. Opportunities for in-stream enhancement for fish habitat and treatment of erosional streambank areas are also available.

- Carry out in-stream enhancement projects below the weir (until improved fish passage is provided past the weir). Address bank erosion downstream of the hatchery weir along the left bank of the stream. Use bioengineering techniques to stabilize the slope
- Enhance in-stream fish habitat at the outside curve of eroding riverbanks (described in Chapter 4) by planting native riparian vegetation and installing woody debris to increase shade and stabilize riverbanks.
- Preserve high quality shoreline conditions by enforcing timber harvest restrictions in the riparian setback zone, per the Draft QIN Forest Management Plan.
- Manage the shoreline area near the Salmon River fish hatchery for low-intensity recreation and work-related access needs by developing formal trails along the shoreline.
- Manage upgrades to fish hatchery facilities to minimize removal of riparian vegetation; preserve a visual buffer between the hatchery and the River.
- Monitor and maintain parking areas and vehicle access areas to control outbreaks of noxious weeds and other harmful invasive species around the fish hatchery facilities.
- Reach Q3 of the Salmon River SAA is partially within the Reservation and partially within the National Forest. Add signage to let recreational hikers, anglers, and boaters know that this reach is managed under Tribal laws for conservation, and specifically define activities allowed not be allowed in Tribal Shoreline Areas.
- Address the fish passage barrier beneath forest road NF 2425 in Reach Q3 (Digital Map A-6).

6.2.3 Site-Specific Opportunities for Restoration and Enhancement in the Raft River and North Fork Raft River Systems

The Raft River and North Fork Raft River include the culturally important Raft River estuary and miles of river that provide important habitat for salmonids and other species. Adjacent land uses are predominantly forestry and recreation. Conservation opportunities for reaches of this river generally pertain to preserving estuarine resources, providing improved access to culturally important areas, and protecting water quality and shoreline habitats from logging, human recreational uses, and future development. The need to improve access conditions to the Raft River Estuary area were covered in the discussion above for the Coastal Shorelines.

- Install barriers at the northern end of Cape Elizabeth Road to keep cars from attempting to go farther.
- Purchase and preserve private fee land parcels north on the Raft River Estuary.
- Prioritize purchase of fee-owned parcels ownership along the Raft River corridor to create a continuous riparian corridor that the Quinault can manage for conservation and riparian enhancement.

6.2.4 Site-Specific Opportunities for Restoration and Enhancement in the Wreck Creek System

The primary restoration and enhancement opportunities at Wreck Creek were already covered in the Coastal Shoreline discussion above.

6.2.5 Site-Specific Opportunities for Restoration and Enhancement in the Moclips River System

Access to the Reservation from points south along State Route 109 requires the crossing of a bridge over the Moclips River just south of the Reservation. As such, opportunities to protect the riparian corridor ensure floodplain storage and connectivity, and other conservation and enhancement measures that mitigate flood hazard and sediment erosion are limited by the critical infrastructure being located outside of the Reservation. There are no significant restoration needs identified in the Moclips SAA within the Reservation. However, if teaming opportunities are available, the actions described below can ensure proper ecological functioning of the river for fish and water quality, but also abate flood hazards that have the potential to affect access to and from Taholah for points south of the Reservation.

- Work with the State of Washington regarding the nearby bridge that crosses the river: make it a priority that the bridge be maintained and/or moved inland as it is important for access to the Reservation.
- Improve flood storage by ensuring that the river has access to large adjacent wetland areas during high flows (see Digital Map A-3) for sediment deposition and hydrologic storage.

6.2.6 Site-Specific Opportunities for Restoration and Enhancement in the Quinault River System

The Quinault River includes two developed areas: Taholah and Amanda Park, at opposite ends of the Reservation. The Quinault SAA provides critical habitat for multiple species of salmonids, and flows through large areas where forestry is the primary land use. General conservation and enhancement opportunities for reaches of this river generally pertain to protecting water quality and shoreline habitats from logging, recreational uses, and future development. Invasive species control is another important consideration for the Quinault River.

The QIN is currently in the planning phase of relocating Taholah Village facilities and some residences from the current village to a new location outside the SAA to mitigate tsunami and sea level rise concerns. After the relocation has been carried out, there may be habitat restoration opportunities in the old village area.

- Collaborate with QIN Department of Natural Resources on the knotweed (*Polygonum* spp.) management control program for the Quinault River corridor.
- Assess conditions at the landslide area defined in Chapter 4 to define drivers for failure at each location. As needed, use bioengineering techniques to stabilize eroding soil areas.
- Decommission unused logging roads from within the SAA and restore by planting native vegetation.
- Quinault River Reaches 2 and 3 have a wide, meandering river floodplain. The extensive channel migration in Reaches 2 and 3 indicates a need for removal and restoration of old road systems and very limited new road entry into the floodplain, to minimize erosion and sediment movement into the river system which could impact salmon habitat.
- Carry out an assessment of noxious weeds and other invasive species in and around Amanda Park and develop a plan for long term control and maintenance to prevent spread into nearby Riverine shoreline areas.

6.3 Lake Quinault

QIN jurisdiction of Lake Quinault extends to the ordinary high water mark (OHWM) of the lake, but only has land-based areas around the southwest end of the Lake near Amanda Park. Land uses by non-tribal entities along the perimeter of the lake, such as recreation, forestry, agriculture, and commercial development, have effects on the lake and shoreline area. Control of land-based operations around the lake perimeter is only possibly through development of clear regulations associated with lake impacts.

Within the Amanda Park area, opportunities for shoreline conservation and enhancement include:

- Maintain development setbacks from the Lake shoreline, and require that new septic system drain fields be setback at least 100 feet from open water.
- Replant and enhance native vegetation along the inner lake shoreline in areas owned by the Tribe.
- Develop a plan to ensure water quality in runoff from the Quinault National Fish Hatchery on Lake Quinault.

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- Washington Department of Fish and Wildlife Priority Habitats and Species database located at: http://wdfw.wa.gov/mapping/phs/
- Washington State Department of Fish and Wildlife Salmonscape database located at: http://apps.wdfw.wa.gov/salmonscape/map.html

8. DIGITAL GIS MAPS

The Figures below are intended only to provide a representation of the large scale digital Shoreline Analysis Areas maps, which are available in GIS or high resolution pdf format through the Quinault Indian Community Development and Planning Department.

- Figure A-1: Vicinity Map
- Figure A-2: Shoreline Analysis Areas
- Figure A-3: Hydrography, Wetlands, and Floodplains
- Figure A-4: Road System
- Figure A-5: Geology, Geohazards, and Tsunami Inundation Areas
- Figure A-6: Restoration Opportunities (Blocked Culverts)
- Figure A-7: Ownership Types in Shoreline Analysis Areas
- Figure A-8: Quinault Soil Survey Mapping in Shoreline Analysis Areas
- Figure A-9: Zoning Classification in Shoreline Analysis Areas

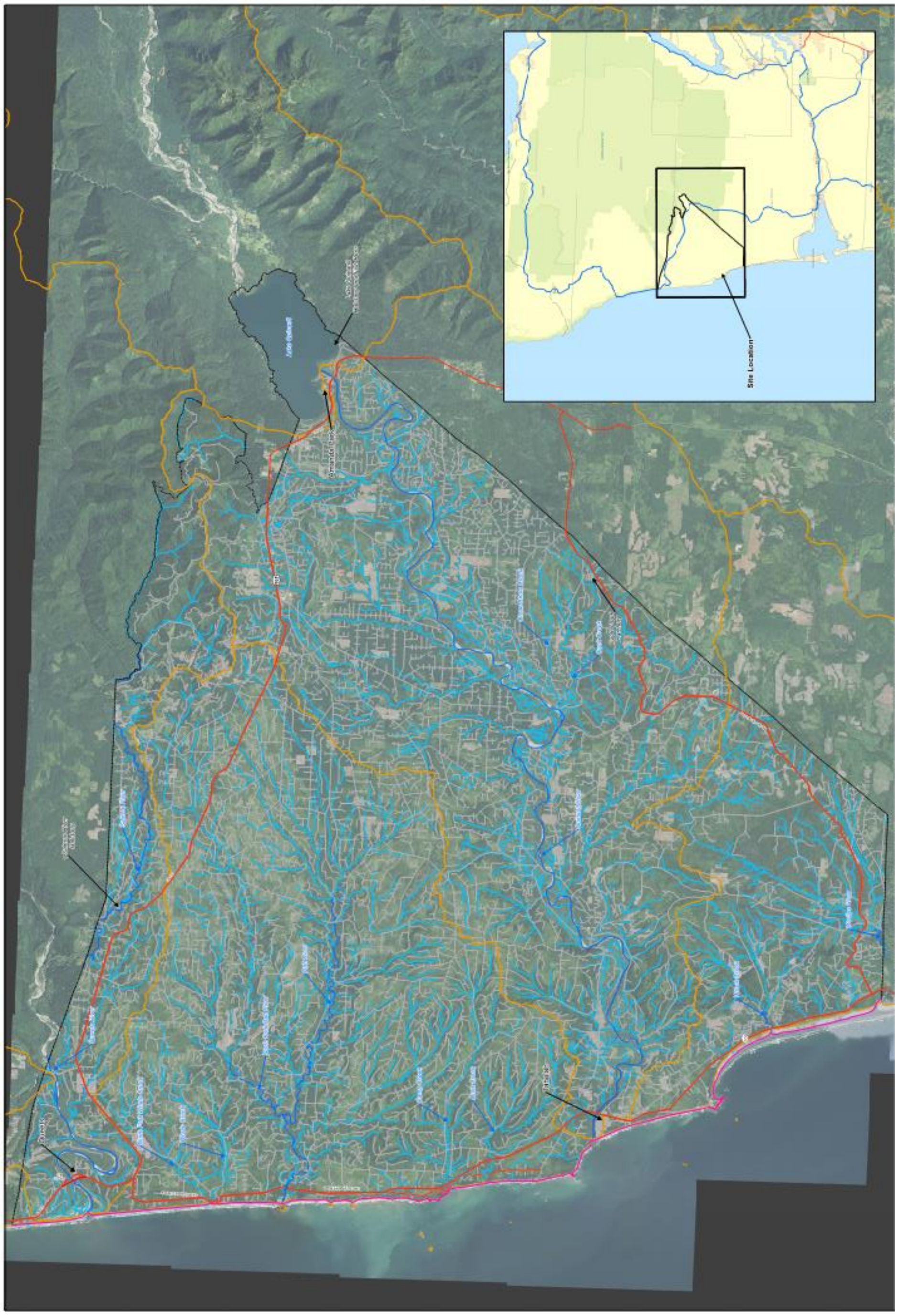


Figure Digital Map A-1: Vicinity Map

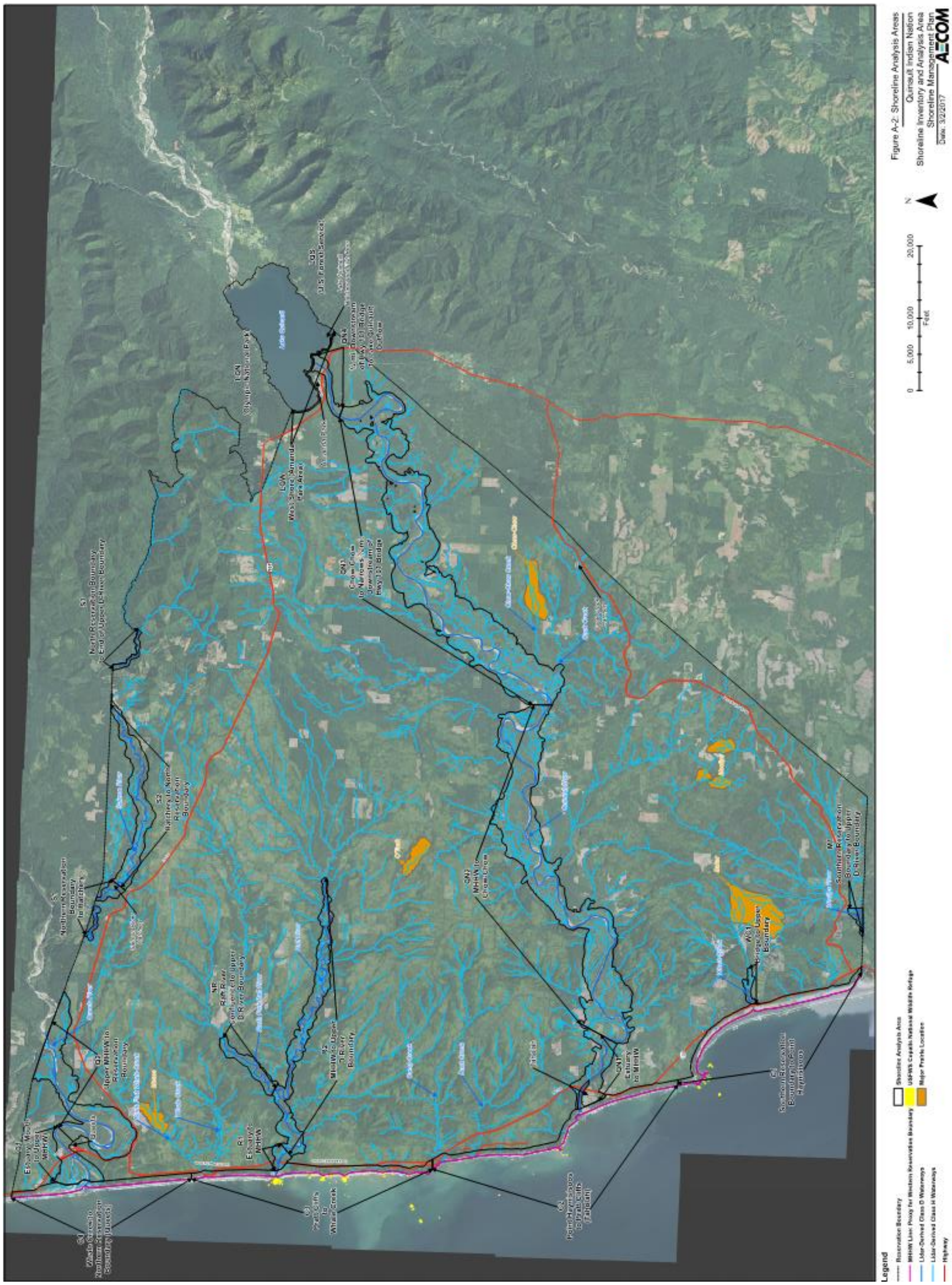


Figure Digital Map A-2: Shoreline Analysis Areas

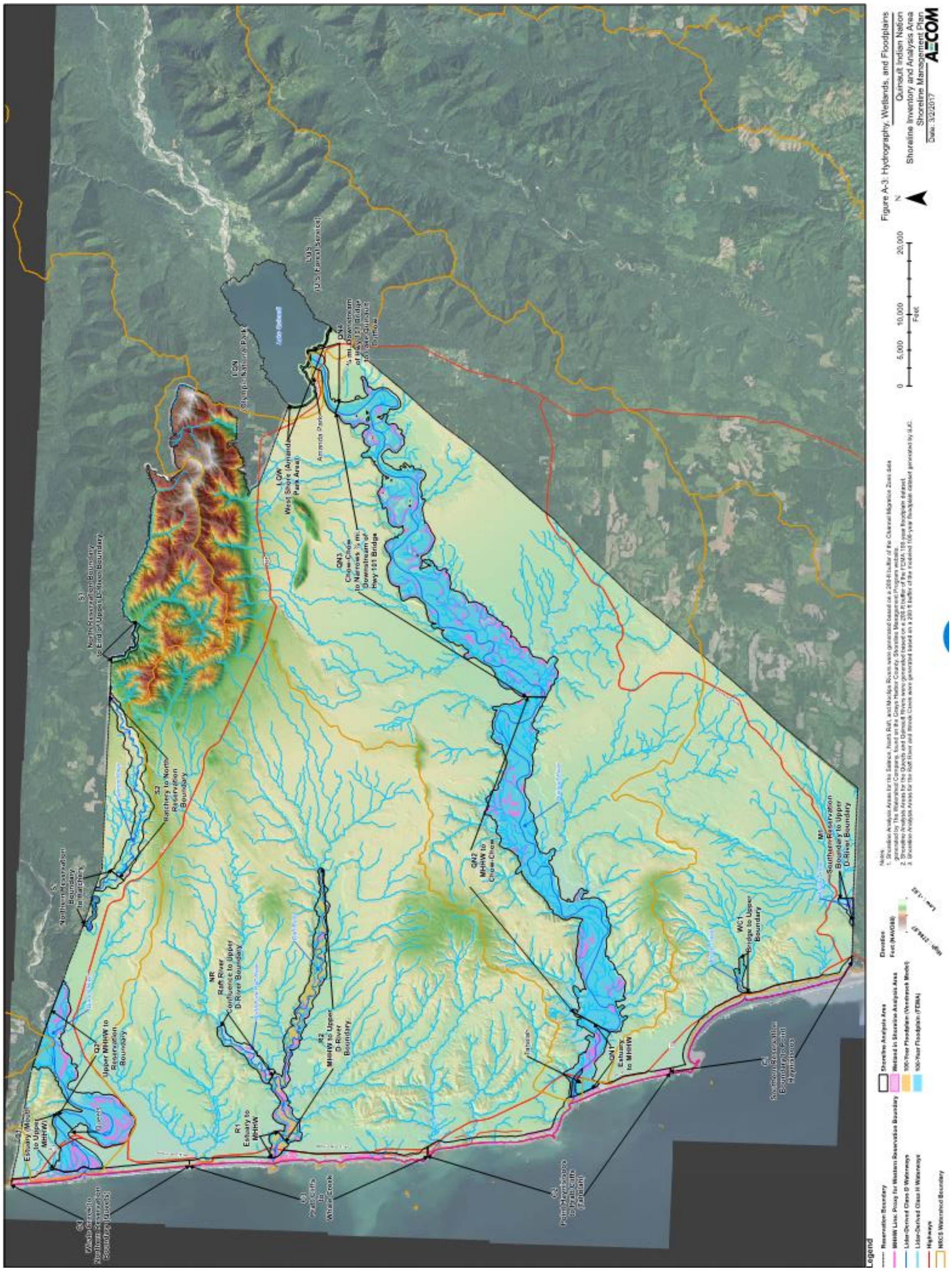


Figure Digital Map A-3: Hydrography, Wetlands and Floodplains

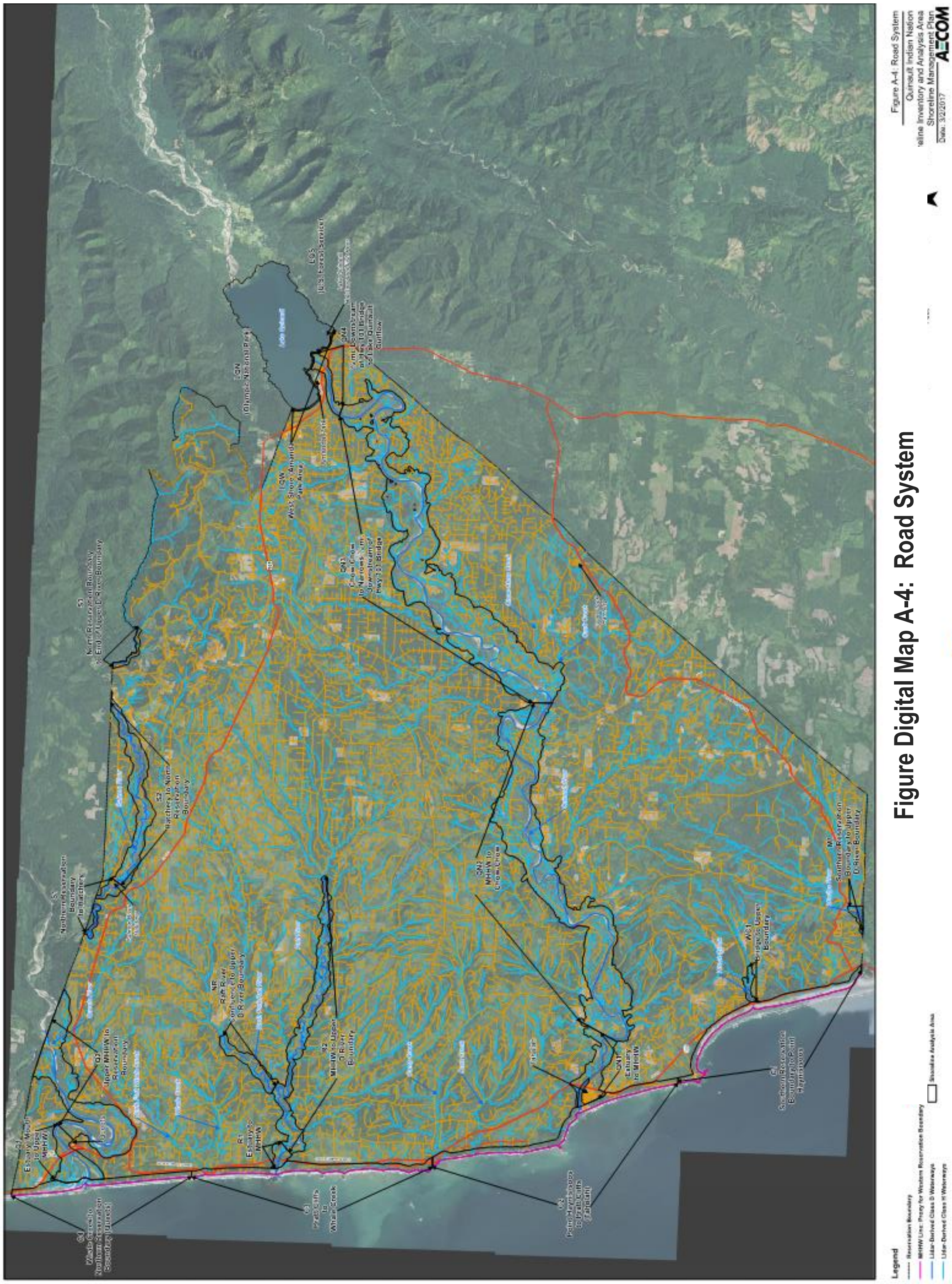


Figure Digital Map A-4: Road System

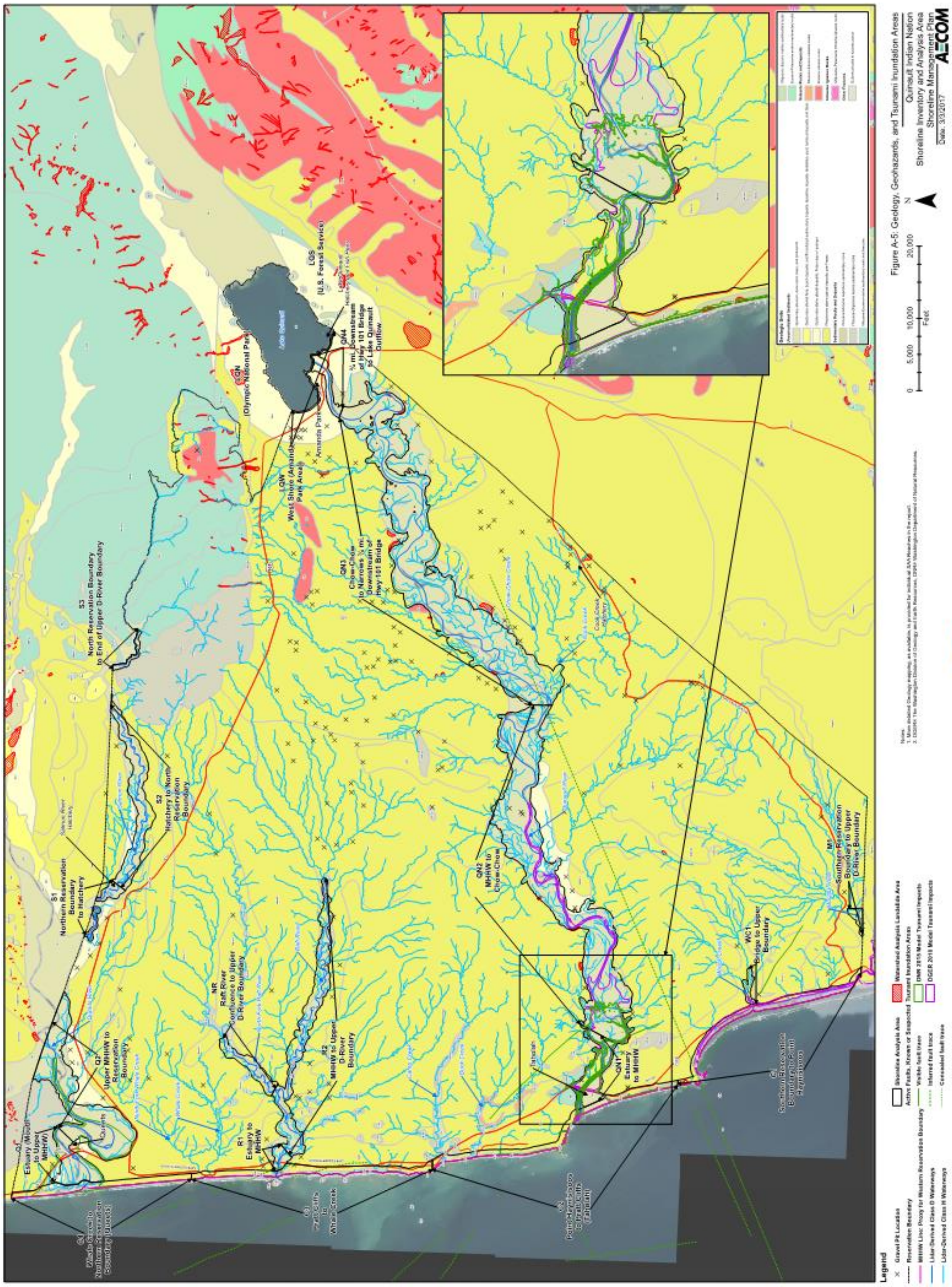
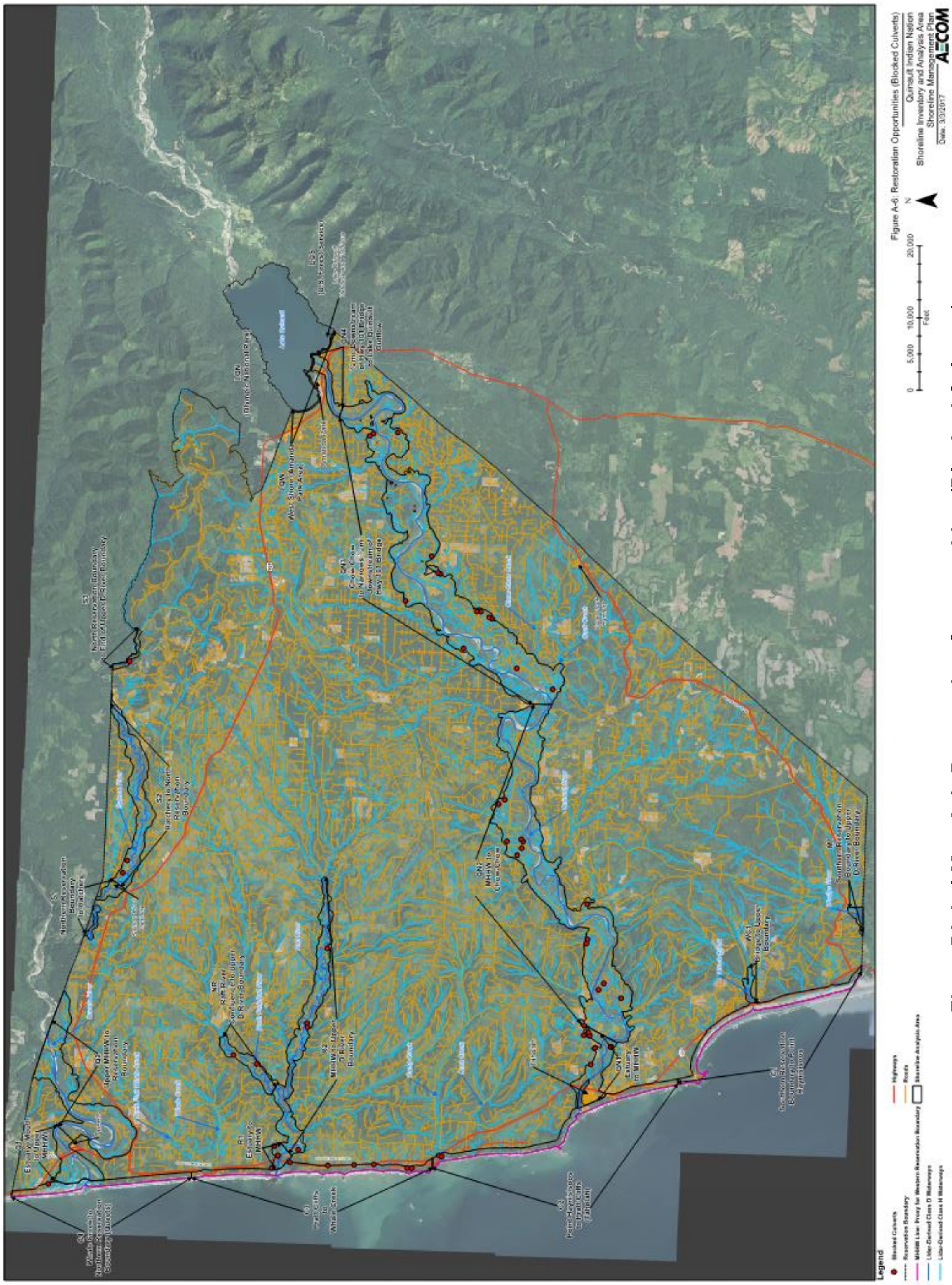


Figure Digital Map A-5: Geology, Geohazards and Tsunami Inundation



FigureDigital Map A-6: Restoration Opportunities (Blocked Culverts)

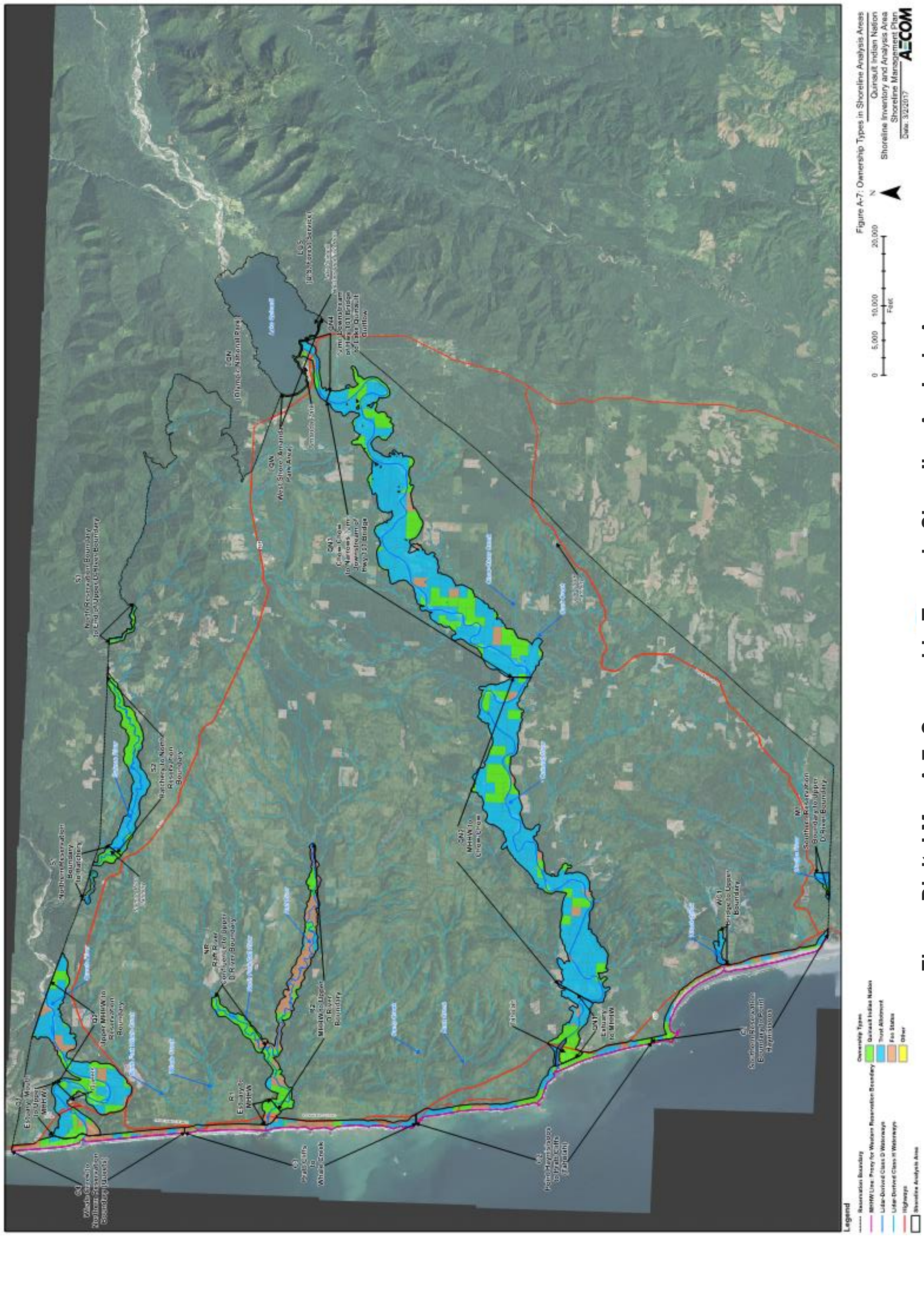


Figure Digital Map A-7: Ownership Types in Shoreline Analysis Areas

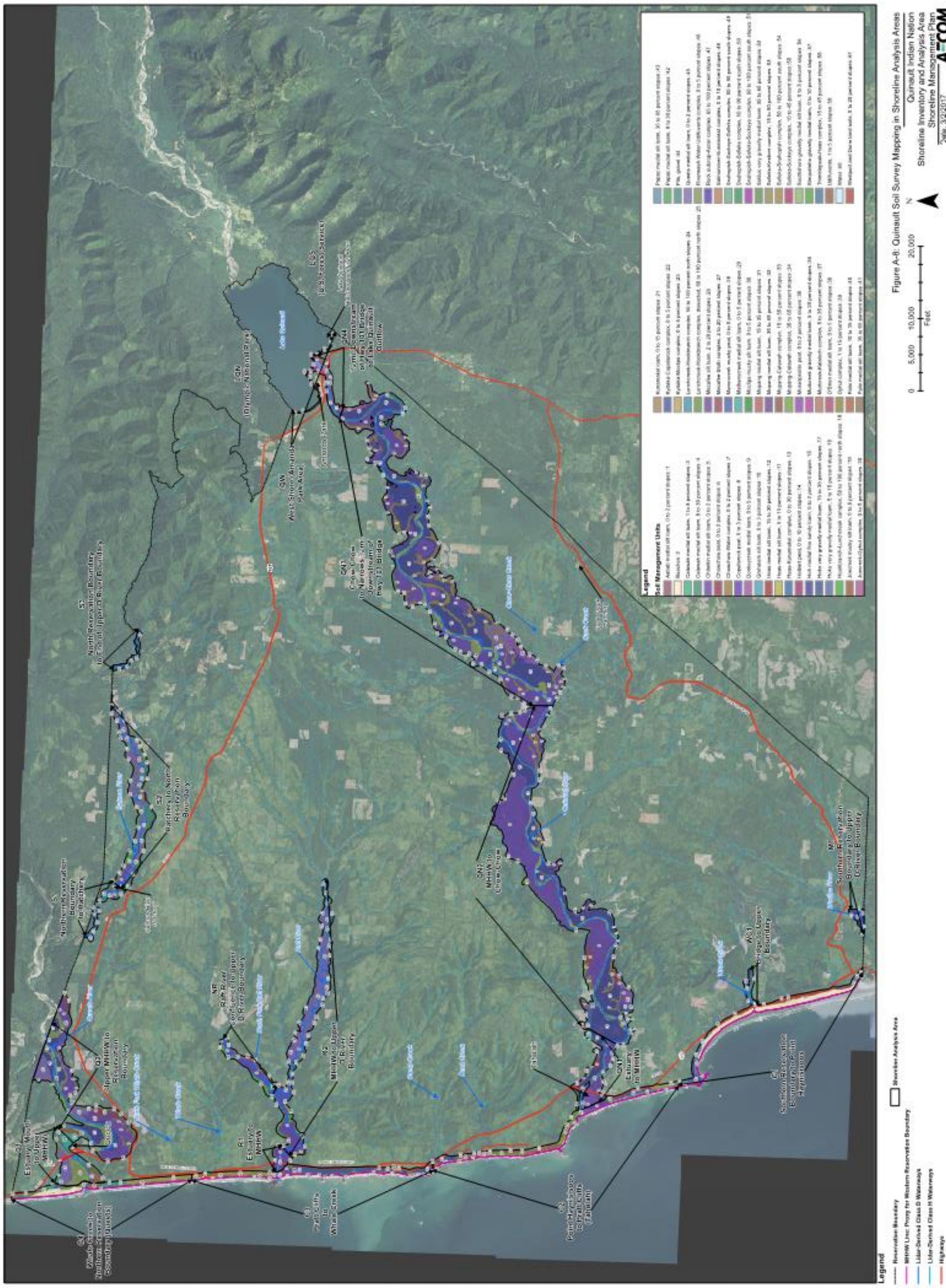


Figure Digital Map A-8: Quinault Soil Survey Mapping in Shoreline Analysis Areas

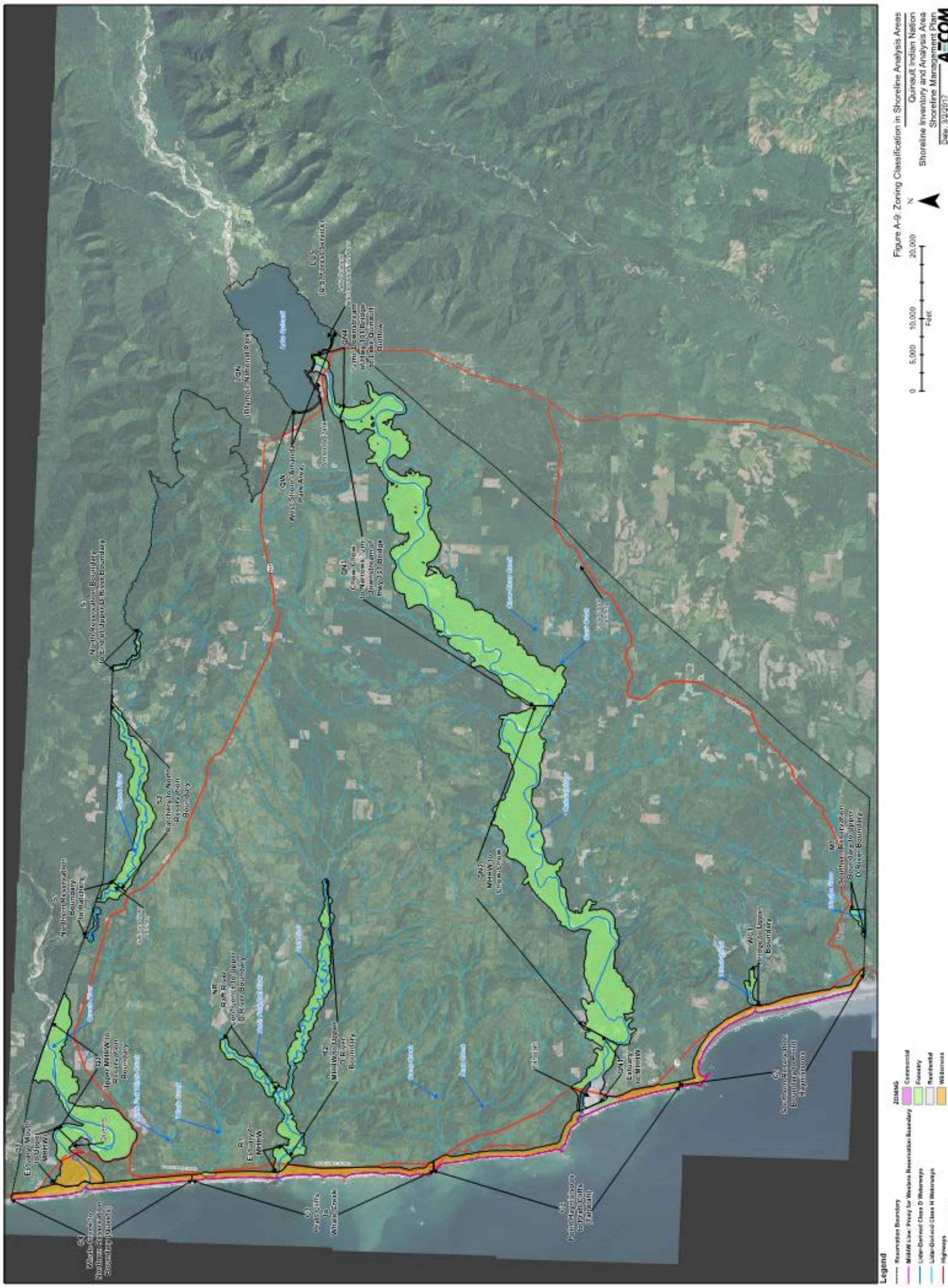
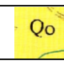
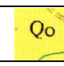
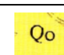
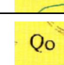
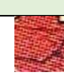
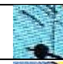


Figure Digital Map A-9: Zoning Classification in Shoreline Analysis Areas

9. APPENDICES

Appendix I: Geologic Map Units at various scale mapping within the Reservation

Table A-25. Description of various geologic map units within the Reservation at a variety of scales finer that the GIS-available version of the 1:100K scale Digital Map A-5.			
GEOLOGIC MAP UNIT	**GEOLOGIC ERA**	**LITHOLOGY**	**AGE OF UNIT (MYBP: MILL. YRS BEF. PRES.)**
Quaternary Period (on both large and small scale maps)			0-1.8 MYBP
Qa	Quaternary	alluvium 	0-1.8 MYBP
Qls	Quaternary	mass-wasting deposits, mostly landslides	0-1.8 MYBP
Qb	Holocene	beach deposits	0-~10,000 years ago
Qad	Pleistocene	alpine glacial drift, Fraser-age	10,000 – 110,000 YBP
Qao	Pleistocene	glacial outwash, alpine, Fraser-age 	10,000 – 110,000 YBP
Qap	Pleistocene	alpine glacial drift, pre-Fraser	110,000yrs – 1.8 MYBP
Qapo	Pleistocene	alpine glacial outwash, pre-Fraser 	110,000yrs – 1.8 MYBP
Qapw (1)	Pleistocene	alpine glacial drift, pre-Wisconsinan, older	110,000yrs – 1.8 MYBP
Qapw (2)	Pleistocene	alpine glacial drift, pre-Wisconsinan, younger	110,000yrs – 1.8 MYBP
Qapwo (1)	Pleistocene	alpine glacial outwash, pre-Wisconsinan, older 	110,000yrs – 1.8 MYBP
Qapwo (2)	Pleistocene	alpine glacial outwash, pre-Wisconsinan, younger 	110,000yrs – 1.8 MYBP
Qapwt(2m)	Pleistocene	alpine glacial till, pre-Wisconsinan, moraine deposits, younger	110,000yrs – 1.8 MYBP
Tertiary Period – small scale Geology map units			1.8 – 65.0 MYBP
PLMn	Pliocene-Miocene	nearshore sedimentary rocks	1.8 – 23.7 MYBP
Mbx	Miocene	tectonic breccia	5.3 – 23.7 MYBP
Mm(r)	Miocene	marine sedimentary rocks, rhythmic thin- to medium-bedded sandstone and shale	5.3 – 23.7 MYBP
Mm(sl)	Miocene	marine sedimentary rocks, siltstone	5.3 – 23.7 MYBP
Mm(ss)	Miocene	marine sedimentary rocks, sandstone	5.3 – 23.7 MYBP
Mml	Miocene	marine clastic rocks, dominantly thick-bedded lithic sandstone	5.3 – 23.7 MYBP
Mv	Miocene	volcanic rocks	5.3 – 23.7 MYBP
MEm(r)	Miocene-Eocene	marine sedimentary rocks, rhythmic thin- to medium-bedded sandstone and shale	5.3 - 54.8 MYBP
Em	Eocene	marine sedimentary rocks	33.7 - 54.8 MYBP
Evb	Eocene	basalt flows	33.7 - 54.8 MYBP
Tertiary Period – large scale Geology map units			1.8 – 65.0 MYBP
Tq (Tqq)	Tertiary	Quinault Formation, Sandstone of Durham, feldspathic sandstone; fossil-bearing 	1.8 – 65.0 MYBP

Tb	Tertiary	basaltic rocks – lava flows 	1.8 – 65.0 MYBP
Tur	Tertiary	mountains – undifferentiated rocks, sandstone dominant; less than 40% siltstone and argillite; some are fossil-bearing 	1.8 – 65.0 MYBP
Thm	Tertiary	mélange rocks, intensively sheared claystone and siltstone containing cemented siltstone, sandstone and altered volcanics	1.8 – 65.0 MYBP
Thv	Tertiary	volcanic rocks, undifferentiated, some mélange rocks	1.8 – 65.0 MYBP
Ths	Tertiary	sandstone, greywacke	1.8 – 65.0 MYBP
Thts	Tertiary	thick-bedded sandstone; minor siltstone inclusions 	1.8 – 65.0 MYBP
Thsr	Tertiary	siltstone, minor sandstone inclusions 	1.8 – 65.0 MYBP
Thsu	Tertiary	sandstone, siltstone, conglomerate undifferentiated 	1.8 – 65.0 MYBP

Appendix II: Primary GIS Data Layers Analyzed for Report

Table A-26. Primary GIS Data Layers Analyzed for The Shoreline Characterization Report		
Layer Name	Summary	Source
CHAMPS	Channel migration zone model	Ecology
Ger_Portal_Landslides_Landforms	Landslides	Ecology
Ger_Portal_Seismogenic_Features	Areas of seismic sensitivity	Ecology
Ger_Portal_Surface Geology_100k	Geologic map[47]	Ecology
Ger_Portal_Tsunami_Inundation	Tsunami inundation area model	Ecology
NHD	Water lines and polygons model	USGS
NWI	Wetland inventory	USFWS
AECOM Probable Wetland Inventory	Modelled wetlands based on NWI, soils data, LiDAR-reinforced hydrography, vegetation data, and forest stands associated with wetlands	AECOM
Parcel	Tax parcels	GHC/QIN
Prairies	Prairies of cultural importance	QIN
Gravel Pit Sites	Inventory of gravel pits from QIN 2011 Comprehensive Plan	QIN
DEM 15ft	Topographic surface elevation model sourced from LiDAR data for entire QIN	QIN
LiDAR-derived stream network	Stream routes derived from LiDAR	QIN
Culvert Inventory	Inventory of all culverts on QIN roads, including fish-passage barriers	QIN
QIN Ownership 2016	General land ownership/allotments	QIN
Road Network 2015	Current roads layer	QIN
Washington Land Use	Ecology's general land use	Ecology
Queets and Quinault 100-Year Floodplain	FEMA floodplain	FEMA
Stand Inventory 2015	Stand age, index (growth potential), dominant vegetation, and riparian reserves status	QIN

[47] The 100k Geology GIS data layer is very general; however, no more detailed Geology map is available in GIS format for the Reservation. For that reason, where more detailed Geology maps were available for subareas within the Reservation, the Geology discussion in the Reach characterization chapter includes discussion that references more detailed Geology mapping infomeration that is not available in GIS format.

Appendix III: Fish and Wildlife Species listed in Washington State Databases as being present in or near the Reservation

Table A-27. List of known natural populations of salmonids in QIN Rivers (Source: State WRIA 21 database).		
River and Population Name	**Species**	**Federal Status**
Queets River		
Queets Bull Trout	Bull Trout	Threatened
Queets Fall Chinook	Chinook	Not Warranted
Queets Spring/Summer Chinook	Chinook	Not Warranted
Queets Fall Chum	Chum	Not Warranted
Queets Coho	Coho	Not Warranted
Queets Coastal Cutthroat	Cutthroat	Not Warranted
Queets Summer Steelhead	Steelhead	Not Warranted
Queets Winter Steelhead	Steelhead	Not Warranted
Clearwater River (Queets Trib.)		
Clearwater Fall Chinook	Chinook	Not Warranted
Clearwater Spring/Summer Chinook	Chinook	Not Warranted
Clearwater Coho	Coho	Not Warranted
Clearwater Summer Steelhead	Steelhead	Not Warranted
Clearwater Winter Steelhead	Steelhead	Not Warranted
Salmon River (Queets Trib.)		
Salmon River Coho	Coho	Not Warranted
Raft River		
Raft Coho	Coho	Not Warranted
Raft/Quinault Coastal Cutthroat	Cutthroat	Not Warranted
Raft Winter Steelhead	Steelhead	Not Warranted
Quinault River		
Quinault Fall Chinook	Chinook	Not Warranted
Quinault Spring/Summer Chinook	Chinook	Not Warranted
Quinault Fall Chum	Chum	Not Warranted

Quinault Coho	Coho	Not Warranted
Raft/Quinault Coastal Cutthroat	Cutthroat	Not Warranted
Quinault Sockeye	Sockeye	Not Warranted
Lower Quinault Winter Steelhead	Steelhead	Not Warranted
Quinault Summer Steelhead	Steelhead	Not Warranted
Upper Quinault Winter Steelhead	Steelhead	Not Warranted
COOK CREEK (QUINAULT TRIB.)		
Cook Creek Fall Chinook	Chinook	Not Warranted
Cook Creek Coho	Coho	Not Warranted
MOCLIPS RIVER		
Moclips Coho	Coho	Not Warranted
Moclips/Copalis Coastal Cutthroat	Cutthroat	Not Warranted
Moclips Winter Steelhead	Steelhead	Not Warranted

Table A-28. List of State WDFW animal species in Grays Harbor County. (Source Washington State WDFW Priority and Habitats and Species database)		
FRESHWATER FISH		
SPECIES/ HABITAT	**STATE STATUS**	**FEDERAL STATUS**
Pacific Lamprey	NA	Species of Concern
River Lamprey	Candidate	Species of Concern
Green Sturgeon	NA	Threatened
White Sturgeon	NA	NA
Olympic Mudminnow	Candidate	NA
Pacific Herring	Candidate	Species of Concern
Eulachon	Candidate	Threatened
Longfin Smelt	NA	NA
Surf smelt	NA	NA
SALMONIDS		
SPECIES/ HABITAT	**STATE STATUS**	**FEDERAL STATUS**
Bull Trout/ Dolly Varden	Candidate	Threatened
Chinook Salmon	Candidate	Threatened
Chum Salmon	Candidate	Threatened
Coastal Res./ Searun Cutthroat	NA	Species of Concern
Coho	NA	NA*
Kokanee	NA	NA
Pink Salmon	NA	NA
Rainbow Trout/ Steelhead/ Inland Redband Trout	Candidate	Threatened
Sockeye Salmon	Candidate	NA*

MARINE FISH		
SPECIES/ HABITAT	**STATE STATUS**	**FEDERAL STATUS**
Pacific Cod	Candidate	Species of Concern
Pacific Hake	Candidate	Species of Concern
Walleye Pollock	Candidate	Species of Concern
Black Rockfish	Candidate	NA
Bocaccio Rockfish	Candidate	Endangered
Brown Rockfish	Candidate	Species of Concern
Canary Rockfish	Candidate	Threatened
China Rockfish	Candidate	NA
Copper Rockfish	Candidate	Species of Concern
Greenstriped Rockfish	Candidate	NA
Quillback Rockfish	Candidate	Species of Concern
Redstripe Rockfish	Candidate	NA
Tiger Rockfish	Candidate	NA
Widow Rockfish	Candidate	NA
Yelloweye Rockfish	Candidate	Threatened
Yellowtail Rockfish	Candidate	NA
Lingcod	NA	NA
Pacific Sand Lance	NA	NA
English Sole	NA	NA
Rock Sole	NA	NA
AMPHIBIANS		
SPECIES/ HABITAT	**STATE STATUS**	**FEDERAL STATUS**
Dunn's Salamander	Candidate	NA
Van Dyke's Salamander	Candidate	Species of Concern
Western Toad	Candidate	Species of Concern
REPTILES		
SPECIES/ HABITAT	**STATE STATUS**	**FEDERAL STATUS**
Pacific Pond Turtle (aka Western Pond Turtle)	Endangered	Species of Concern
BIRDS		
SPECIES/ HABITAT	**STATE STATUS**	**FEDERAL STATUS**
Brandt's Cormorant	Candidate	NA
Brown Pelican	Endangered	Species of Concern
Common Loon	Sensitive	NA
Common Murre	Candidate	NA
Marbled Murrelet	Threatened	Threatened
Short-tailed Albatross	Candidate	Endangered
Tufted Puffin	Candidate	Species of Concern
Western grebe	Candidate	
W WA nonbreeding concentrations of: Loons, Grebes, Cormorants, Fulmar, Shearwaters, Storm-petrels, Alcids	NA	NA
W WA breeding concentrations of: Cormorants, Storm-petrels, Terns, Alcids	NA	NA
Great Blue Heron	NA	NA

Brant	NA	NA
Cavity-nesting ducks: Wood Duck, Barrow's Goldeneye, Common Goldeneye, Bufflehead, Hooded Merganser	NA	NA
Western Washington nonbreeding concentrations of: Barrow's Goldeneye, Common Goldeneye, Bufflehead	NA	NA
Harlequin Duck	NA	NA
Trumpeter Swan	NA	NA
Waterfowl Concentrations	NA	NA
Bald Eagle	Sensitive	Species of Concern
Golden Eagle	Candidate	NA
Northern Goshawk	Candidate	Species of Concern
Peregrine Falcon	Sensitive	Species of Concern
Mountain Quail	NA	NA
Sooty Grouse	NA	NA
Wild Turkey	NA	NA
Snowy Plover	Endangered	Threatened
W WA nonbreeding concentrations of: Charadriidae, Scolopacidae, Phalaropodidae	NA	NA
Band-tailed Pigeon	NA	NA
Yellow-billed Cuckoo	Candidate	Candidate
Spotted Owl	Endangered	Threatened
Vaux's Swift	Candidate	NA
Pileated Woodpecker	Candidate	NA
Purple Martin	Candidate	NA
Streaked Horned Lark	Endangered	Candidate
MAMMALS (OCEAN)		
SPECIES/ HABITAT	**STATE STATUS**	**FEDERAL STATUS**
Dall's Porpoise	NA	NA
Blue Whale	Endangered	Endangered
Humpback Whale	Endangered	Endangered
Gray Whale	Sensitive	NA
Sperm Whale	Endangered	Endangered
Harbor Seal	NA	NA
Orca (Killer Whale)	Endangered	Endangered
Pacific Harbor Porpoise	Candidate	NA
California Sea Lion	NA	NA
Steller (Northern) Sea Lion	Threatened	Threatened
MAMMALS (LAND)		
SPECIES/ HABITAT	**STATE STATUS**	**FEDERAL STATUS**
Roosting Concentrations of: Big-brown Bat, Myotis bats, Pallid Bat	NA	NA
Townsend's Big-eared Bat	Candidate	Species of Concern
Keen's Long-eared Bat	Candidate	NA
Olympic Marmot	Candidate	NA
Western Gray Squirrel	Threatened	Species of Concern
Western Pocket Gopher	Threatened	Candidate
Fisher	Endangered	Candidate
Marten	NA	NA

Columbian Black-tailed Deer	NA	NA
Mountain Goat	NA	NA
Elk	NA	NA
INVERTEBRATES		
SPECIES/ HABITAT	**STATE STATUS**	**FEDERAL STATUS**
Butter Clam	NA	NA
Native Littleneck Clam	NA	NA
Manila Clam	NA	NA
Olympia Oyster	Candidate	NA
Pacific Oyster	NA	NA
Razor Clam	NA	NA
Dungeness Crab	NA	NA
Pandalid shrimp (Pandalidae)	NA	NA
Johnson's Hairstreak	Candidate	NA
Makah Copper	Candidate	Species of Concern
Puget Blue	Candidate	NA
Red Urchin	NA	NA

Appendix IV: Plant Species listed in Washington State Databases or otherwise documented as being present in or near the Reservation

Table A-29. Washington Natural Heritage Information System: List of Known Occurrences of Rare Plants in Grays Harbor County, September 2014

SCIENTIFIC NAME	COMMON NAME	STATE STATUS[48]	FEDERAL STATUS
Arenaria paludicola	swamp sandwort	X	LE
Carex anthoxanthea	yellow-flowered sedge	S	
Carex circinata	coiled sedge	S	
Carex macrochaeta	large-awned sedge	T	
Cimicifuga elata	tall bugbane	S	SC
Claytonia multiscapa ssp. *pacifica*	Pacific lance-leaved springbeauty	T	
Cochlearia groenlandica	scurvygrass	S	
Dodecatheon austrofrigidum	frigid shooting-star	E	SC
Erigeron aliceae	Alice's fleabane	S	
Erigeron peregrinus var. *thompsonii*	Thompson's wandering daisy	S	
Erythronium quinaultense	Quinault fawn-lily	T	
Erythronium revolutum	pink fawn-lily	S	
Iwatsukiella leucotricha	Iwatsukiella Moss	E	
Montia diffusa	branching montia	S	
Parnassia palustris var. *neogaea*	northern grass-of-parnassus	S	
Plantago macrocarpa	Alaska plantain	S	
Polemonium carneum	great polemonium	T	
Racomitrium aquaticum	aquatic racomitrium moss	R1	
Ranunculus cooleyae	Cooley's buttercup	S	
Sanguisorba menziesii	Menzies' burnet	T	
Sanicula arctopoides	bear's-foot sanicle	E	SC
Schistostega pennata	luminous moss	R1	
Sericocarpus rigidus	white-top aster	S	SC
Synthyris schizantha	fringed synthyris	R1	
Tetraphis geniculata	tetraphis moss	R1	

[48] X = Potentially extinct; S = Sensitive; T = Threateneed; E = Endangered; R1 = Review group 1, of potential concer, but need field work; SC = Federal Species of Concern; LE = Federally Endangered

Table A-30. List of species documented on the Reservation during field work in 2015-2016 by Jeff Walker, Botanist (AECOM).

FAMILY	SPECIES	COMMON NAME	Hitchcock & Cronquist Synonym	N/ I*	STATUS
TREES					
Betulaceae	*Alnus rubra*	red alder		n	
Cupressaceae	*Thuja plicata*	western redcedar		n	
Pinaceae	*Abies amabilis*	Pacific silver fir		n	
Pinaceae	*Picea sitchensis*	Sitka spruce		n	
Pinaceae	*Pinus contorta* var. *contorta*	shore pine		n	
Pinaceae	*Pinus contorta* var. *latifolia*	lodgepole pine		n	
Pinaceae	*Pinus monticola*	western white pine		n	
Pinaceae	*Pseudotsuga menziesii* var. *menziesii*	Douglas-fir		n	
Pinaceae	*Tsuga heterophylla*	western hemlock		n	
Salicaceae	*Populus trichocarpa*	black cottonwood		n	
Sapindaceae	*Acer macrophyllum*	bigleaf maple		n	
Aquifoliaceae	*Ilex aquifolium*	English holly		i	
SHRUBS					
Caprifoliaceae	*Lonicera involucrata* var. *involucrata*	black twinberry		n	
Caprifoliaceae	*Sambucus racemosa* var. *racemosa*	red elderberry		n	
Caprifoliaceae	*Symphoricarpos albus*	common snowberry		n	
Cornaceae	*Cornus sericea*	red-osier dogwood	*C. stolonifera*	n	
Ericaceae	*Gaultheria shallon*	salal		n	
Ericaceae	*Kalmia microphylla* var. *occidentalis*	bog laurel	includes *K. occidentalis*	n	
Ericaceae	*Menziesia ferruginea*	fool's-huckleberry		n	
Ericaceae	*Rhododendron groenlandicum*	bog Labrador tea	*Ledum g.*	n	
Ericaceae	*Vaccinium ovatum*	evergreen huckleberry		n	
Ericaceae	*Vaccinium oxycoccos*	bog cranberry		n	
Ericaceae	*Vaccinium parvifolium*	red huckleberry		n	
Ericaceae	*Vaccinium uliginosum*	bog blueberry		n	
Fabaceae	*Cytisus scoparius*	Scot's broom		i	Class B
Grossulariaceae	*Ribes bracteosum*	stink currant		n	
Myricaceae	*Myrica californica*	Pacific bayberry		n	
Myricaceae	*Myrica gale*	sweet gale		n	
Rhamnaceae	*Frangula purshiana*	cascara	*Rhamnus p.*	n	
Rosaceae	*Malus fusca*	western crabapple	*Pyrus f.*	n	
Rosaceae	*Oemleria cerasiformis*	osoberry		n	
Rosaceae	*Physocarpus capitatus*	Pacific ninebark		n	
Rosaceae	*Rosa nutkana* var. *nutkana*	Nootka rose		n	
Rosaceae	*Rubus bifrons*	Himalayan blackberry	*R. discolor* (also *R. armeniacus*)	i	Class C
Rosaceae	*Rubus laciniatus*	evergreen blackberry		i	Class C

Rosaceae	*Rubus leucodermis*	blackcap raspberry		n	
Rosaceae	*Rubus parviflorus*	thimbleberry		n	
Rosaceae	*Rubus spectabilis*	salmonberry		n	
Rosaceae	*Rubus ursinus*	dewberry	*R. u.* var. *macropetalus*	n	
Rosaceae	*Spiraea douglasii* var. *douglasii*	Douglas' spiraea		n	
Salicaceae	*Salix hookeriana*	Hooker willow		n	
Salicaceae	*Salix lasiandra* var. *lasiandra*	Pacific willow		n	
Salicaceae	*Salix sitchensis*	Sitka willow		n	
Sapindaceae	*Acer circinatum*	vine maple		n	
HERBS	-	-	-	-	-
Apiaceae	*Angelica lucida*	sea-watch		n	
Apiaceae	*Glehnia littoralis* ssp. *leiocarpa*	beach carrot	*G. leiocarpa*	n	
Apiaceae	*Heracleum maximum*	common cow parsnip	*H. lanatum*	n	
Apiaceae	*Ligusticum apiifolium*	celery-leaf wild lovage		n	
Apiaceae	*Oenanthe sarmentosa*	American water-parsley		n	
Araceae	*Lysichiton americanus*	skunk cabbage	*Lysichitum americanum*	n	
Asparagaceae	*Camassia quamash var. ??*	camas		n	
Asparagaceae	*Maianthemum dilatatum*	false lily-of-the-valley		n	
Asteraceae	*Achillea millefolium*	yarrow		n	
Asteraceae	*Ambrosia chamissonis*	silver beachweed		n	
Asteraceae	*Anaphalis margaritacea*	pearly everylasting		n	
Asteraceae	*Artemisia suksdorfii*	coastal mugwort		n	
Asteraceae	*Bellis perennis*	English daisy		i	
Asteraceae	*Cirsium arvense*	Canada thistle		i	
Asteraceae	*Cirsium* sp.	thistle			
Asteraceae	*Cirsium vulgare*	bull thistle		i	
Asteraceae	*Erigeron peregrinus* var. *thompsonii*	Thompson's wandering daisy		n	Sensitive
Asteraceae	*Gamochaeta ustulata*	purple cudweed	*Gnaphalium purpureum*	n	
Asteraceae	*Gnaphalium uliginosum*	marsh cudweed		i	
Asteraceae	*Hypochaeris radicata*	hairy cat's-ear		i	
Asteraceae	*Leucanthemum vulgare*	ox-eye daisy	*Chrysanthemum leucanthemum*	i	Class C
Asteraceae	*Matricaria discodea*	pineapple weed		n	
Asteraceae	*Petasites frigidus* var. *palmatus*	western coltsfoot		n	
Asteraceae	*Senecio jacobaea*	tansy ragwort		i	
Asteraceae	*Senecio minimus*	Australian bornweed	*Erechtites minimus*	i	
Asteraceae	*Senecio sylvaticus*	woodland groundsel		i	
Asteraceae	*Senecio vulgaris*	common groundsel		i	
Asteraceae	*Solidago lepida*	goldenrod		n	
Asteraceae	*Sonchus asper*	prickly sow thistle		i	
Asteraceae	*Symphyotrichum subspicatum*	Douglas aster	*Aster subspicatus*	n	

Asteraceae	*Tanacetum bipinnatum*	dune tansy		n	
Asteraceae	*Taraxacum officinale*	common dandelion		i	
Balsminaceae	*Impatiens* sp.	jewelweed		?	
Boraginaceae	*Hydrophyllum tenuipes*	Pacific waterleaf		n	
Boraginaceae	*Myosotis laxa*	small forget-me-not		n	
Boraginaceae	*Romanzoffia tracyi*	Tracy's mistmaiden		n	
Brassicaceae	*Barbarea orthoceras*	American wintercress		n	
Brassicaceae	*Cakile edentula*	American searocket		i	
Brassicaceae	*Cardamine angulata*	seaside bittercress		n	
Brassicaceae	*Cardamine hirsuta*	hairy bittercress		i	
Brassicaceae	*Nasturtium officinale*	watercress	*Rorippa nasturtium-aquaticum*	i	
Caryophyllaceae	*Cerastium glomeratum*	sticky mouse-ear chickweed		i	
Caryophyllaceae	*Honckenya peploides* ssp. *major*	sea purslane		n	
Caryophyllaceae	*Spergula arvensis*	corn spurry		i	
Caryophyllaceae	*Spergularia rubra*	red sandspurry		i	
Caryophyllaceae	*Stellaria calycantha*	northern bog starwort	*S. c.* var. *c.*	n	
Caryophyllaceae	*Stellaria crispa*	crisped starwort		n	
Caryophyllaceae	*Stellaria media*	common chickweed		i	
Convolvulaceae	*Convolvulus soldanella*	beach morning-glory		n	
Cornaceae	*Cornus unalaschkensis*	western bunchberry	*C. canadensis* (misapplied)	n	
Droseraceae	*Drosera rotundifolia*	round-leaf sundew		n	
Fabaceae	*Lathyrus japonicus* var. *maritimus*	beach pea	*L. j.*	n	
Fabaceae	*Lathyrus latifolius*	everlasting pea		i	
Fabaceae	*Lotus corniculatus*	bird's-foot trefoil		i	
Fabaceae	*Lupinus littoralis*	seashore lupine		n	
Fabaceae	*Trifolium pratense*	red clover		i	
Fabaceae	*Trifolium repens*	white clover		i	
Fabaceae	*Trifolium wormskioldii*	salt marsh clover	*T. wormskjoldii*	n	
Fabaceae	*Vicia nigricans* ssp. *gigantea*	giant vetch	*V. n.*	n	
Gentianaceae	*Gentiana sceptrum*	staff gentian		n	
Hydrocharitaceae	*Elodea canadensis*	common waterweed		n	
Hypericaceae	*Hypericum anagalloides*	bog St. John's-wort		n	
Lamiaceae	*Lycopus* sp.	water-horehound		n	
Lamiaceae	*Prunella vulgaris*	self-heal			
Lamiaceae	*Stachys mexicana*	Mexican hedge-nettle		n	
Liliaceae	*Lilium columbianum*	Columbian lily		n	
Liliaceae	*Streptopus amplexifolius*	clasping twisted-stalk		n	
Lythraceae	*Lythrum portula*	spatula-leaf loosestrife		i	
Melanthiaceae	*Veratrum* sp.	wild hellebore		n	
Melanthiaceae	*Xerophyllum tenax*	beargrass		n	
Menyanthaceae	*Fauria crista-galli*	deer cabbage	*Nephrophyllidium crista-galli*	n	
Montiaceae	*Claytonia sibirica*	Siberian miner's lettuce	*Montia sibirica*	n	

Myrsinaceae	*Lysimachia nummularia*	creeping-Jenny		i	
Myrsinaceae	*Trientalis europaea*	Arctic starflower	*T. arctica*	n	
Nyctaginaceae	*Abronia latifolia*	yellow sand-verbena		n	
Nymphaeaceae	*Nuphar polysepala*	spatterdock	*N. polysepalum*	n	
Onagraceae	*Chamerion angustifolium* ssp. *circumvagum*	fireweed	*Epilobium a.*	n	
Onagraceae	*Epilobium ciliatum*	willowherb	*E. watsonii*	n	
Onagraceae	*Ludwigia palustris*	marsh primrose-willow		n	
Orchidaceae	*Platanthera dilatata*	white bog orchid	*Habenaria dilatata*	n	
Orchidaceae	*Spiranthes romanzoffiana*	hooded ladies-tresses		n	
Orobanchaceae	*Boschniakia hookeri*	Vancouver groundcone		n	
Oxalidaceae	*Oxalis oregana*	Oregon wood-sorrel		n	
Papaveraceae	*Corydalis scouleri*	Scouler's corydalis		n	
Papaveraceae	*Dicentra formosa* ssp. *formosa*	Pacific bleeding heart		n	
Plantaginaceae	*Callitriche heterophylla*	different-leaved water-starwort		n	
Plantaginaceae	*Callitriche stagnalis*	pond water-starwort		i	
Plantaginaceae	*Digitalis purpurea*	foxglove		i	
Plantaginaceae	*Plantago lanceolata*	English plantain		i	
Plantaginaceae	*Plantago macrocarpa*	Alaska plantain		n	Sensitive
Plantaginaceae	*Plantago major*	common plantain		i	
Plantaginaceae	*Veronica americana*	American brooklime		n	
Plantaginaceae	*Veronica officinalis*	common speedwell		i	
Polygonaceae	*Persicaria maculosa*	spotted lady's-thumb	*Polygonum persicaria*	i	
Polygonaceae	*Polygonum bohemicum*	Bohemian knotweed		i	
Polygonaceae	*Polygonum* sp.	knotweecd		i	
Polygonaceae	*Rumex acetosella*	sheep sorrel		i	
Polygonaceae	*Rumex maritimus ssp. fueginus*	golden dock		n	
Polygonaceae	*Rumex obtusifolius*	bitter dock		i	
Polygonaceae	*Rumex occidentalis*	western dock		n	
Potamogetonaceae	*Potamogeton natans*	floating-leaved pondweed		n	
Ranunculaceae	*Anemone oregana*	Oregon anemone		n	
Ranunculaceae	*Ranunculus repens*	creeping buttercup	*R. r.* vars *pleniflorus, repens*	i	
Ranunculaceae	*Trautvetteria caroliniensis*	false bugbane		n	
Rosaceae	*Aruncus dioicus* var. *acuminatus*	Sylvan goatsbeard	*A. sylvester*	n	
Rosaceae	*Comarum palustre*	marsh cinquefoil	*Potentilla palustris*	n	
Rosaceae	*Fragaria chiloensis*	coastal strawberry		n	
Rosaceae	*Geum macrophyllum*	largeleaved avens		n	
Rosaceae	*Potentilla anserina* ssp. *pacifica*	Pacific silverweed	*P. pacifica*	n	
Rosaceae	*Sanguisorba officinalis*	great burnet		n	
Rubiaceae	*Galium trifidum* var. *pacificum*	small bedstraw		n	

Saxifragaceae	*Boykinia intermedia*	boykinia	*B. major* (misapplied)	n	
Saxifragaceae	*Tolmiea menziesii*	piggyback plant		n	
Typhaceae	*Typha latifolia*	common cattail		n	
Violaceae	*Viola glabella*	stream violet		n	
GRASSES, RUSHES, & SEDGES					
Cyperaceae	*Bolboschoenus maritimus* ssp. *paludosus*	saltmarsh bulrush	*Scirpus maritimus*	n	
Cyperaceae	*Carex aquatilis* var. *dives*	Sitka sedge	*C. sitchensis*	n	
Cyperaceae	*Carex echinata ssp. phyllomanica*	coastal star sedge	*C. phyllomanica*	n	
Cyperaceae	*Carex exsiccata*	big inflated sedge	*C. vesicaria* var. *major*	n	
Cyperaceae	*Carex livida*	pale sedge		n	
Cyperaceae	*Carex lyngbyei*	Lyngbye's sedge		n	
Cyperaceae	*Carex macrocephala*	bighead sedge		n	
Cyperaceae	*Carex obnupta*	slough sedge		n	
Cyperaceae	*Carex utriculata*	inflated sedge		n	
Cyperaceae	*Eleocharis* sp.	spikerush			
Cyperaceae	*Eriophorum chamissonis*	russet cottongrass		n	
Cyperaceae	*Rhyncospora alba*	white beakrush		n	
Cyperaceae	*Scirpus atrocinctus*	common woolly-sedge		n	
Cyperaceae	*Scirpus microcarpus*	small-fruited bulrush		n	
Cyperaceae	*Trichophorum cespitosum*	tufted clubrush	*Scirpus cespitosus*	n	
Juncaceae	*Juncus balticus*	Baltic rush		n	
Juncaceae	*Juncus bufonius* var. *bufonius*	toad rush		n	
Juncaceae	*Juncus bulbosus*	spreading rush		i	
Juncaceae	*Juncus canadensis*	Canadian rush		i	
Juncaceae	*Juncus ensifolius*	daggerleaf rush		n	
Juncaceae	*Juncus laccatus*	shiny rush	*J. effusus* var. *gracilis*	n	
Juncaceae	*Juncus* spp.	rushes			
Juncaceae	*Luzula parviflora*	small-flowered woodrush		n	
Juncaceae	*Luzula* sp.	woodrush			
Poaceae	*Agrostis* sp.	bentgrass			
Poaceae	*Agrostis stolonifera*	spreading bent		i	
Poaceae	*Aira caryophyllea* var. *caryophyllea*	delicate silver hairgrass		i	
Poaceae	*Aira praecox*	early silver hairgrass		i	
Poaceae	*Ammophila arenaria* ssp. *arenaria*	European beachgrass		i	
Poaceae	*Anthoxanthum odoratum*	sweet vernalgrass		i	
Poaceae	*Bromus* sp.	brome			
Poaceae	*Calamagrostis* sp.	bluejoint		n	
Poaceae	*Dactylis glomerata*	orchargrass		i	
Poaceae	*Deschampsia cespitosa* ssp. *cespitosa*	tufted hairgrass	*D. caespitosa*	n	
Poaceae	*Elymus glaucus*	blue wildrye		n	
Poaceae	*Holcus lanatus*	velvetgrass		i	

Poaceae	*Hordeum brachyantherum* ssp. *brachyantherum*	meadow barley		n	
Poaceae	*Leymus mollis* var. *mollis*	American dunegrass	*Elymus mollis*	n	
Poaceae	*Lolium perenne*	perennial ryegrass		i	
Poaceae	*Phalaris arundinacea*	reed canarygrass		i	
Poaceae	*Poagrostis aequivalvis*	Arctic bent	*Agrostis aequivalvis*	n	
Poaceae	*Trisetum cernuum*	nodding trisetum		n	
FERNS & ALLIES					
Blechnaceae	*Blechnum spicant*	deer fern		n	
Dennstaedtiaceae	*Pteridium aquilinum* var. *pubescens*	bracken fern		n	
Dryopteridaceae	*Athyrium filix-femina* var. *cyclosorum*	common ladyfern		n	
Dryopteridaceae	*Dryopteris expansa*	northern wood fern	*D. austriaca* in part	n	
Dryopteridaceae	*Polystichum munitum*	western sword fern	*P. m.* var. *munitum*	n	
Equisetaceae	*Equisetum arvense*	common horsetail		n	
Lycopodiaceae	*Lycopodium clavatum*	common clubmoss		n	
Polypodiaceae	*Polypodium glycyrrhiza*	licorice fern		n	
Polypodiaceae	*Polypodium scouleri*	coast polypody		n	
Selaginellaceae	*Selaginella* sp.	selaginella		n	

Appendix V: Reference Weather Stations near the Reservation

There are two reference weather stations located near the Reservation that can be used to track long-term climate change. One station is located near the eastern end of the Reservation, and the other is located northwest of the Reservation.

The QUINAULT 4 NE, WA237 station is at 276 feet elevation, located northeast of Lake Quinault in the National Park. This station provides a reference record of climate for the eastern Reservation. The weather station has been in place since 1971, with most consistent data reported between 2006 and 2010. More detailed long-term data may be available on request.

The QUILLAYUTE STATE AIRPORT, WA US (GHCND:USW00094240) station is north of the Reservation, but near the coast. It provides a reference record of climate for the western Reservation.

Table A-31. Long-term average weather statistics at the weather station at the Quillayute Airport

QUILLAYUTE STATE AIRPORT, WA US (GHCND:USW00094240) (From NOAA National Centers for Environmental Information)
https://www.ncdc.noaa.gov/cdo-web/datasets/normal_mly/stations/GHCND:USW00094240/detail

Climate Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Avg. Max Temp. F	47.1	49.1	51.4	54.8	59.5	63.1	67.4	68.6	66.2	58.2	50.3	46	56.8
Avg. Min Temp. F	36	35.2	36.8	38.6	43.1	47.5	50.5	50.5	46.9	41.8	38.1	34.7	41.6
Avg. Temp. F	41.6	42.1	44.1	46.7	51.3	55.3	58.9	59.6	56.6	50.0	44.2	40.4	49.2
Avg. Monthly PPT (in)	14.6	10.4	10.8	7.85	5.11	3.5	1.98	2.5	3.8	10.5	15.5	13.0	99.5

Table A-32. Long-term average weather statistics at the Quinault 4 weather station at Lake Quinault

QUINAULT 4 NE (04237) Weather Station (Product generated by ACIS - NOAA Regional Climate Centers)
https://gis.ncdc.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=hourly&layers=00000001&extent=-139.2:12.7:-50.4:57.8&node=gis

Climate Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Max Temp. F	42.9	48.3	48.9	54.0	61.0	65.2	73.4	71.1	67.4	57.4	48.0	42.0	56.6
Avg. Min Temp. F	33.7	35.1	34.9	37.0	41.5	46.2	50.7	51.3	48.3	42.3	38.0	33.5	41.1
Avg. Temp. F	38.3	41.7	41.9	45.5	51.3	55.7	62.1	61.2	57.9	49.8	43.0	37.7	48.8
Avg. Monthly PPT (in)	26.14	12.73	16.26	10.37	6.87	4.04	3.10	4.27	6.06	16.03	29.32	20.65	153.82

Appendix VI Definitions

Allotted Land (or Allotment) * -- Reservation land the federal government distributed to individual Indians, generally in 40-, 80-, and 160-acre parcels [and is held in trust by the federal government (BIA)].

The Tribal member can mortgage, gift or sell the property as they see fit with the approval of the BIA.

Allottee *-- An individual who owns an undivided interest in a parcel of allotted land.

Base Flood -- Per QIN Title 48, *"…the flood having a one percent chance of being equaled or exceeded in any given year; also referred to as the '100-year flood.'"*

Beach – Per QIN Title 48, *"…the land between the ordinary high tide line and extreme low tide line".*

Commercial Zone (C) – Per QIN Title 48, *"The purpose of this zone is to provide an open commercial zone for commercial light industrial activities from gas stations and supermarkets to warehousing, home-based businesses, and light manufacturing. … Permitted uses include, but are not limited to, home-based businesses, grocery stores, drug stores, self-service laundries, general retail and specialty shops, banks, offices, cafes, restaurants, motels, appropriate entertainment and recreation facilities, parks and boat launchings, public buildings, museums, post offices, and police and fire stations. Light auto repair, boat repair and construction, seafood processing and merchandising, arts and crafts and marinas are also classified as commercial activities."*

Fee Simple (Fee Land) * -- Land ownership status in which the owner holds title to and control of the property. The owner may make decisions about land use or sell the land without government oversight.

Floodway -- Per QIN Title 48, *"…means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot".*

Forestry Zone (F) – Per QIN Title 48, *"(a) The purpose of the Forestry Zone is to allow forestry management and its related activities. (b) In the Forestry Zone, no uses and structures shall be permitted unless for forestry uses. For the purpose of this Title, owner's residences and residences of labor employed in the industry are classified as forestry uses and shall be permitted in the Forestry Zone. Saw and shake mills are conditional uses*."

Forestry and Industrial Buffer Zone – Per Qin Title 48, *"(a) Forestry and industrial uses may have significant impacts at some distance from the actual site where the use occurs. In order to control such impacts, buffer zones are hereby established along the zone boundaries inside of the Forestry and Industrial Zones. The minimum width of the buffer strips shall be 300 feet.*

Wider strips may be designated where terrain or other conditions increase the distance of potential impacts. (b) All forestry and industrial uses within the buffer strips are conditional uses. Permit applications must indicate any possible adverse impacts or permitted uses in the neighboring zones and what steps will be taken to minimize them. The Planning Commission will approve forestry and industrial uses in the buffer strips only when assured there will be no significant adverse impacts on permitted uses in other zones."

Industrial Zone (I) – Per QIN Title 48, *"The purpose of the Industrial Zone is to provide an exclusive zone for industrial activities that have limited noxious emissions in fumes, particulate matter, waste water, noise or vibrations. Land uses particularly appropriate for this zone include, but are not limited to: light manufacturing involving shake mills, the assembly of small machined parts, research activities and warehousing. Other land uses permitted include log transfers, heavy equipment maintenance, saw mill and other timber product processing."*

Marine Bluffs – Per QIN Title 48, *"…means coastal features that resulted from wave erosion undercutting uplands located contiguous to the shoreline, creating vertical cliffs that are an important source of sediment for coastal drift processes and/or the landforms created by these processes".*

Natural Resource Activities – Per QIN Title 48, *"…means any activity conducted on or directly pertaining to forest lands, tidelands, rivers, lakes, springs, streams, sloughs, ponds, groundwater, wetlands, marshes and any other body of water, including but not limited to:*

(1) Road and trail construction
(2) Harvesting, final and intermediate
(3) Pre-commercial thinning
(4) Reforestation
(5) Fertilization
(6) Prevention and suppression of disease and insect damage
(7) Salvage of trees and down logs
(8) Brush control
(9) Gravel and mineral extraction
(10) Any activity with the potential to effect tidelands, rivers, lakes, springs, streams, sloughs, ponds, groundwater, wetlands, marshes and any other body of water.

Nonpoint Source (NPS) Pollution (per QDNR FMP Glossary) -- Pollution that enters any waters from any dispersed land-based or water-based activities, including but not limited to, atmospheric deposition, surface water runoff from agricultural lands, urban areas or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the National Pollutant Discharge Elimination System (NPDES) program.

Point Source Pollution (per QDNR FMP Glossary) -- Any discernible, confined and discrete conveyance, including, but not limited to, any pipe, ditch, channel, sewer, tunnel, conduit, well, discrete fissure,
container, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Pollutant (water) (per QDNR FMP Glossary) -- Includes dredged spoil; solid waste; incinerator residue; filter backwash; sewage; garbage; sewage sludge; munitions; chemical wastes; biological materials;
radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.)); heat; wrecked, or discarded equipment; rock; sand; cellar dirt; and industrial, municipal, and agricultural waste discharged into water.

Pollution (water) (per QDNR FMP Glossary) -- Includes such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the Tribe, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the Tribe as will or is likely to create a nuisance or impair any beneficial use of such waters.

Quinault Indian Nation (QIN) (per QDNR FMP Glossary) -- A party, along with the United States, to the Treaty of Olympia of 1855 (12 STAT. 97; II Kappler719); federal recognition of the QIN has continued to this day. The Reservation was created on July 1, 1855 and expanded in 1873. The Enabling Act under which Washington was admitted to statehood did not become law until 2/22/1889, and the State was not admitted to the Union until 11/11/1889. Thus, the Reservation predates the existence of the State of Washington. The QIN is organized under a constitution adopted by the membership on March 22, 1975. The Quinault Business Committee (QBC) is the duly constituted governing body of the QIN by the authority of Article V of the Constitution and Bylaws of the QIN.

Quinault-Owned Lands -- The QIN has control over all, or a certain portion, of trust land on the Reservation. The QIN can then assign a particular member the right to use the land for a variety of reasons.

Quinault Shoreline Management Plan -- In the Reservation, regulated Shorelines include the Pacific Coast; all "Designated" (D) Rivers (Queets, Salmon, Raft, North Fork Raft, Quinault and Moclips [portion within the Reservation only]); Lake Quinault, and Wreck Creek (a smaller stream system than the D-Rivers) but with features that require special management to protect Tribal interests). Smaller rivers and streams are not regulated under the Quinault Shoreline Management Plan.

Resource Extraction – Per QIN Title 48, *"…means the extraction of minerals, including solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gases. The term also includes quarrying; well operation; milling, such as crushing, screening, washing and flotation; and other preparation customarily done at the extraction site or as a part of the extractive activity".*

Residential Zone (R) -- Per QIN Title 48, *"In the Residential Zone, no uses and structures shall be permitted unless for residential purposes or accessory to a residential use, which includes mixed uses of civic and public uses and home-based businesses. For the purpose of this Title, schools, churches, cemeteries, public buildings and their land uses, apartment houses, and other multiple dwellings are classified as residential uses."*

Roads (per QDNR FMP Glossary) –

- **Primary Road** (Indian Reservation Road). A public use road within the BIA road system that provides general mobility and access to and within the Reservation. For the purpose of this document, these roads are defined as collector roads that collect traffic for arterial roads (U.S. Highway 101 and State Route 109) and provide connections between Reservation communities, Reservation administrative facilities, or natural resource activities.
- **Secondary Road**. A forest road that is not constructed for public use. These roads are engineered and constructed to various standards depending on when they were constructed and by whom. They have the following in common:
  - surfaced for all weather use;
  - constructed permanent drainage, i.e., culverts, bridges, and ditches that are installed to pass water and fish, and will meet water turbidity minimums as stated in the U. S. EPA and Washington State Water Quality Standards;
  - engineered for vertical and horizontal curves; and
  - are used for multiple entries to access and manage the forestland—especially for log and cedar salvage harvest.
- **Spur Road**. A non-public road that is constructed for one harvest/salvage entry. Spur roads have installed drainage to permit water flow and fish passage, and meet water turbidity minimums. They are not engineered and usually do not have the common constructed items described for secondary roads.
- **Abandonment**. A means of permanently closing a road that will prepare the ground for vegetative growth, and cause or allow it to revert to its original profile. Abandoning the road includes removing ditch lines, culverts, and bridges; stabilizing cut and fill slopes; and (where necessary to prevent erosion) the seeding, fertilizing, and mulching of bare mineral soil (and other ID Team approved measures).
- **Closure**. Blocking the road by means of a ditch, gate, cement barrier, or guardrail that closes a road to motor vehicle traffic, but does not require the removal of culverts and bridges. However, culverts requiring annual debris removal or showing signs of frequent (every year or two) overflow resulting in road/ditch erosion may be removed or replaced with properly sized culverts or bridges.

Shoreline – The edge of any large water body – saltwater or freshwater. The size or character of the adjacent water body is used to define a subset of specific Shorelines that merit specific regulatory protection. In Washington state -- excluding Native American Reservations --

Shorelines regulated under the Shoreline Management Act include the Pacific Coast; the Straits of Juan de Fuca; the Puget Sound; the Hood Canal; freshwater lakes more than 20 acres in size; and rivers up to the point of less than 20 cfs flow. The Quinault Shoreline Management Plan defines regulated shorelines differently (see definition of Shoreline Analysis Area).

Shoreline Analysis Area (SAA) – The Quinault SAAs include the Shoreline plus a certain area of land upslope or landward from the edge of the Shoreline water body. Depending on the type of shoreline and adjacent land use, certain activities may be encouraged or limited through Shoreline Management Plan regulations and policies.

The 14 Riverine SAAs are as follows: Queets River (2 Reaches); Salmon River (3 Reaches); Raft River (2 Reaches); North Fork Raft River (1 Reach); Quinault River (4 Reaches); Wreck Creek (1 Reach); Moclips River (1 Reach). The Riverine Reach SAA includes the 100-year floodplain of each river plus 200 feet landward from the edge of the 100-year floodplain.

The 4 Pacific Coast SAAs are as follows: Reach 1 is from the southern Reservation boundary north to include Point Haynisisoos; Reach 2 is from Point Haynisisoos to Pratt Cliffs (includes Taholah and Quinault River mouth); Reach 3 is from Pratt Cliffs to Whale Creek (includes Raft River estuary); Reach 4 is from Whale Creek to the northern Reservation Boundary (Includes Queets estuary). The Coastal Reaches include all lands at least 800 feet landward of the Mean High High Water (MHHW) line at the beach, as defined on Quinault GIS maps from NOAA elevation data. The Coastal SAA is wider at certain locations under two different conditions:

1. Where the eastern edge of the standard Coastal SAA is within 200 feet of the State Route 109 or U.S. Highway 101 ROW, the 800 feet measurement from the MHHW line is expanded to include the highway ROW;
2. Where the coastal bluffs are not within in the standard SAA, the eastern edge of the SAA is expanded landward to define a new SAA edge 300 feet inland from the edge of vegetation at the bluff.

Shoreline Management Plan -- The QIN has chosen to develop a Shoreline Management Plan which will provide guidance and regulations for managing critical Shorelines on Reservation lands. The Nation has chosen to adapt certain aspects of the Washington State Shorelines Regulatory Program to create opportunities for improved management of Shoreline Areas within the Reservation. The QIN is not regulated by the state in this matter, but may choose to adapt state policy and programs on matters of mutual concern and/or benefit, such as environmental protection.

Tribal Land (per QDNR FMP Glossary) -- Land owned in either trust or fee status by the Quinault Indian Nation.

Stream Type (per QDNR FMP Glossary) –

- **Type D Waters**: Designated Waters. All waters designated as Type D by the Quinault Indian Nation. These waters include the entire reach of the Quinault River; all of the

Queets that flows through the Reservation, the Salmon River up to the confluence point with the south fork; the main stem of the Raft River up to the confluence point with Meadow and Lunch Creeks; the north fork of the Raft up to the confluence point with Wolf Creek; the main stem of the Wreck up to the confluence point with the north fork; the main stem of the Moclips River up to the confluence point with the north fork; and all of Lake Quinault.

- **Type H Waters**: Waters presumed to provide fish habitat. All stream segments not designated as Type D waters with a defined channel greater than or equal to two feet between the OHWMs and a gradient of 16% or less. If a stream segment meets the gradient requirements and originates in a wetland, then the stream segment and associated wetland are Type H water. Stream segments with a defined channel greater than or equal to two feet between the OHWMs and a gradient of greater than 16% and less than or equal to 20% with a contributing basin of 50 acres or greater are Type H water. The ID Team will determine the break between Type H and Type O waters.
- **Type O Waters**: Other waters. All natural stream segments with a defined channel not classified as Type D or Type H.

Wetlands -- Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wetlands will, under normal circumstances, have these three components at the same place and time:

- Hydrophytic vegetation – More than 50% dominance by plant species classified on the National Wetland Plant List as Facultative (FAC), Facultative Wet (FACW) or Obligate (OBL);
- Hydric soils -- Soils that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part; and
- Wetland hydrology – Where, under normal circumstances, the land surface is either inundated or the upper portion of the soil is saturated at a sufficient frequency and duration to create anaerobic conditions.

Wetlands within the Reservation are identified and delineated (boundary marked) using the 1987 Federal Manual for Identifying and Delineating Jurisdictional Wetlands, applying guidance from the 2010 (or as updated) Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0).

Wetlands (per QDNR FMP Glossary) -- (the following definition was taken from the EPA's web page): Generally, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin, December 1979). Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance. Indeed, wetlands are found from the tundra to the tropics and on every continent except Antarctica. The term wetlands means "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

- **Forested wetlands**: any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of > 30%.
- **Non-forested wetlands**: any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of < 30%.
- **Type A Non-Forested Wetland**:
    - All non-forested wetlands that are greater than or equal to 0.5 acre in size (including any acreage of open water where the water is completely surrounded by the wetland) and are associated with at least 0.5 acre of ponded or standing open water. The open water must be present on the site for at least 7 consecutive days between April 1 and October 1.
    - All forested and non-forested bogs greater than or equal to 0.25 acre.
- **Type B Non-Forested Wetland**:
    - All other non-forested wetlands greater than 0.50 acre.
- **Bog**: wetlands that have the following characteristics: Hydric organic soils (peat and/or muck) typically 16 inches or more in depth (except over bedrock or hardpan); and vegetation such as sphagnum moss, labrador tea, bog laurel, bog rosemary, sundews, and sedges; bogs may have an overstory of spruce, western hemlock, lodgepole pine, cedar, white pine, crabapple, or aspen, and may be associated with open water. This includes nutrient-poor fens

Wetland Indicators -- Wetlands can be identified and delineated in the field at any time of year by looking for presence of specifically defined plant, soil and hydrology indicators, which are defined and described in 2010 (or as updated) Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0) and associated guidance and research documents (such as Field Indicators of Hydric Soils in the United States, version 8 [as updated]).

These Indicators have been extensively tested, and if properly applied, can be used to identify those areas that are inundated or saturated by surface or groundwater at a frequency and duration to create anaerobic conditions, even if wetland hydrology is not currently present.

Wilderness Zone (W) – Per QIN Title 48, *"(a) The purpose of the Wilderness Zone is to retain the natural environment. Individual residences are a conditional use in the Wilderness Zone. No individual residence shall be permitted without full compliance with applicable tribal standards and individual approval by the Quinault Business Committee. The Quinault Planning Commission shall establish standards for building in the Wilderness Zone. Selective logging, where conditions are appropriate, are conditional uses in the Wilderness Zone, provided that the aesthetic and wilderness values of the site can be maintained. The tribal Forestry Department shall make recommendations for each site concerning the appropriateness of the proposed operations and conditions to be imposed to ensure the wilderness values are maintained. The Quinault Planning Commission shall establish minimum standards for conditional use. (b) Individual campsites shall be a conditional use in the Wilderness Zone. No campsite shall be used for overnight camping until the requirements of the Sanitation Title have been met. Any campsite upon which a fire is to be built shall have prior approval of the Forestry Division of the Quinault Department of Natural Resources and Economic Development. The Quinault Planning Commission shall establish minimum standards for this conditional use. No subdivision or plat shall be approved within the boundaries of the Wilderness Zone."*